Nokia Customer Care
RH-29 Series Cellular Phones

6b - RF Troubleshooting

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RF Troubleshooting

Abbreviations in troubleshooting charts

AFC	Automatic Frequency Control
AGC	Automatic Gain Control
ADC	Analog Digital Converter
ASIC	Application Specific Integrated Circuit
BB	Base band
DC	Direct Current
GSM	Global System for Mobile Communication
HB	High Band
LB	Low Band
LNA	Low Noise Amplifier
LO	Local Oscillator
LPF	Loop Filter
PA	Power Amplifier
DCS	Digital Cellular System
PLL	Phase Locked Loop
PWB	Printed Wired Board
RH-29	Project Type Designator
RF	Radio Frequency
RX	Receiver
SA	Spectrum analyzer
TX	Transmitter
UEM	Universal Energy Management

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UHF	Ultra High Frequency
UPP	Universal Phone Processor
VCO	Voltage-controlled oscillator
VCXO	Voltage-controlled Crystal Oscillator
VHF	Very High Frequency

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Introduction

Two types of measurements have to be done for repair of the phone boards:

- RF measurements shall be done using a Spectrum Analyzer together with a high-frequency probe. (Note, that signal will be significantly attenuated). Correct attenuation can be checked by using a “good” phone board, for example.

- LF (Low frequency) and DC measurements shall be done with a an oscilloscope together with an 10:1 probe.

Always make sure that the measurement set-up is calibrated when measuring RF parameters at the RF connector. Remember to include the correct losses in the module repair jig and the connecting cable when realigning the phone.

Most RF semiconductors are static discharge sensitive. ESD protection must be taken into account during repair (ground straps and ESD soldering irons).

Mjoelner RF ASIC is moisture sensitive. Therefore, Mjoelner RF ASIC must be pre-baked prior to soldering.

Rx calibration done via Phoenix software is temperature sensitive because of calibration of 26 MHz reference oscillator (VCXO). According to Mjoelner specification ambient temperature has to be in a range from 22°C to 36°C.

Apart from key-components described in this document there are a lot of discrete components (resistors, inductors and capacitors) for which troubleshooting is done by checking if soldering of the component is done properly and checking if the component is missing from PWB. Capacitors can be checked for short-circuiting and resistors for value by means of an ohm-meter, but be aware in-circuit measurements should be evaluated carefully.

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RF Key component placement

Figure 1: RF key component placement

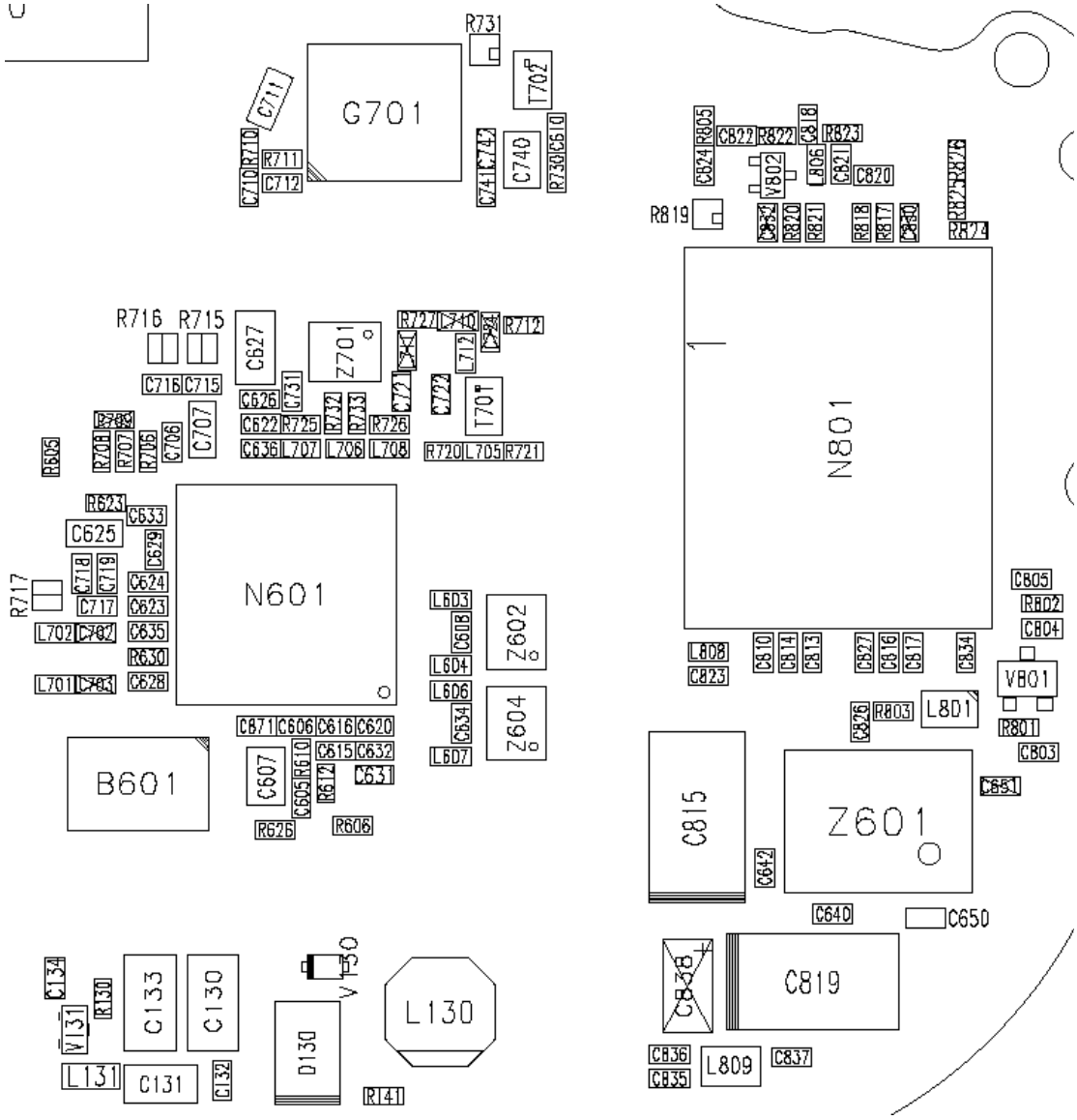

Table 1: Key components

Reference number	Name	Reference number	Name
N601	Mjoelner RF ASIC		
B601	26 MHz Xtal		
Z602	GSM1800 RX SAW		
Z604	900 RX SAW filter	L801	Directional Coupler
Z701	900 TX SAW filter	V801	Detector Diode
T701	GSM1800 TX Balun	Z601	Antenna switch
V802	900 TX buffer	N801	Power Amplifier

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Reference number	Name	Reference number	Name
G701	3.7 GHz VCO		
T702	VCO Balun		

RF measurement points

RF supply points

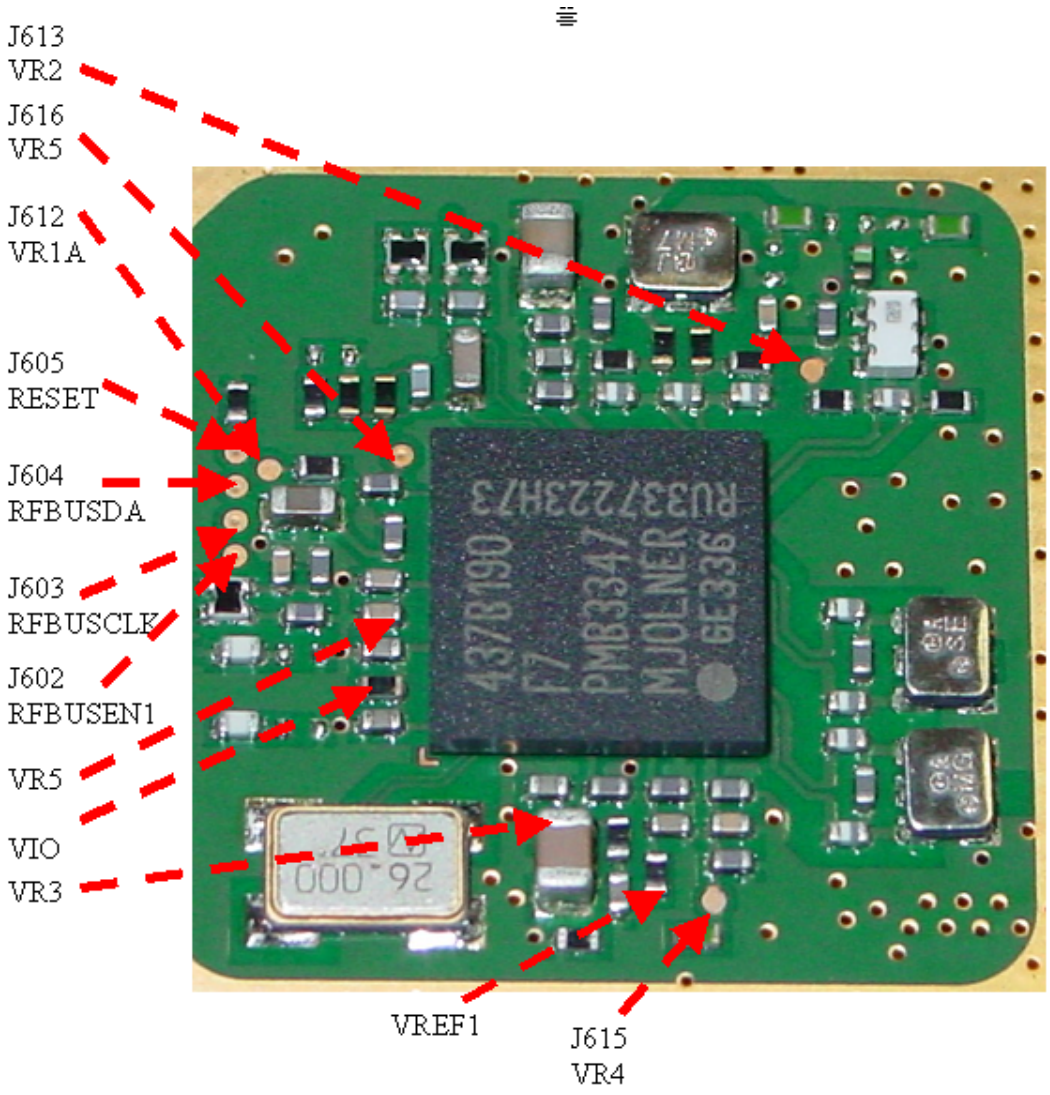

Figure 2: RF Supply points inside Mjoelner can

RF power supplies are generated in the UEM and can be measured either in the Mjoelner can or in the baseband can. Arrows mark the measurement points inside the pictures.

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Measurement points in the receiver

Figure 3: Rx measurement points in antenna switch.

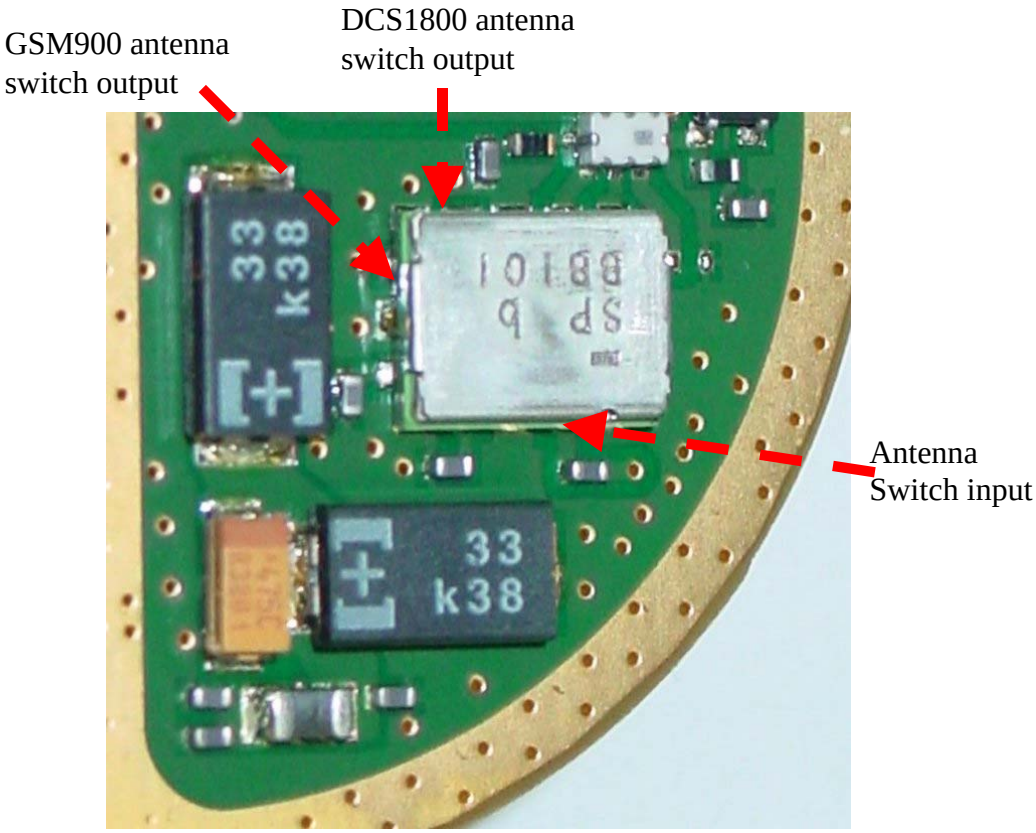
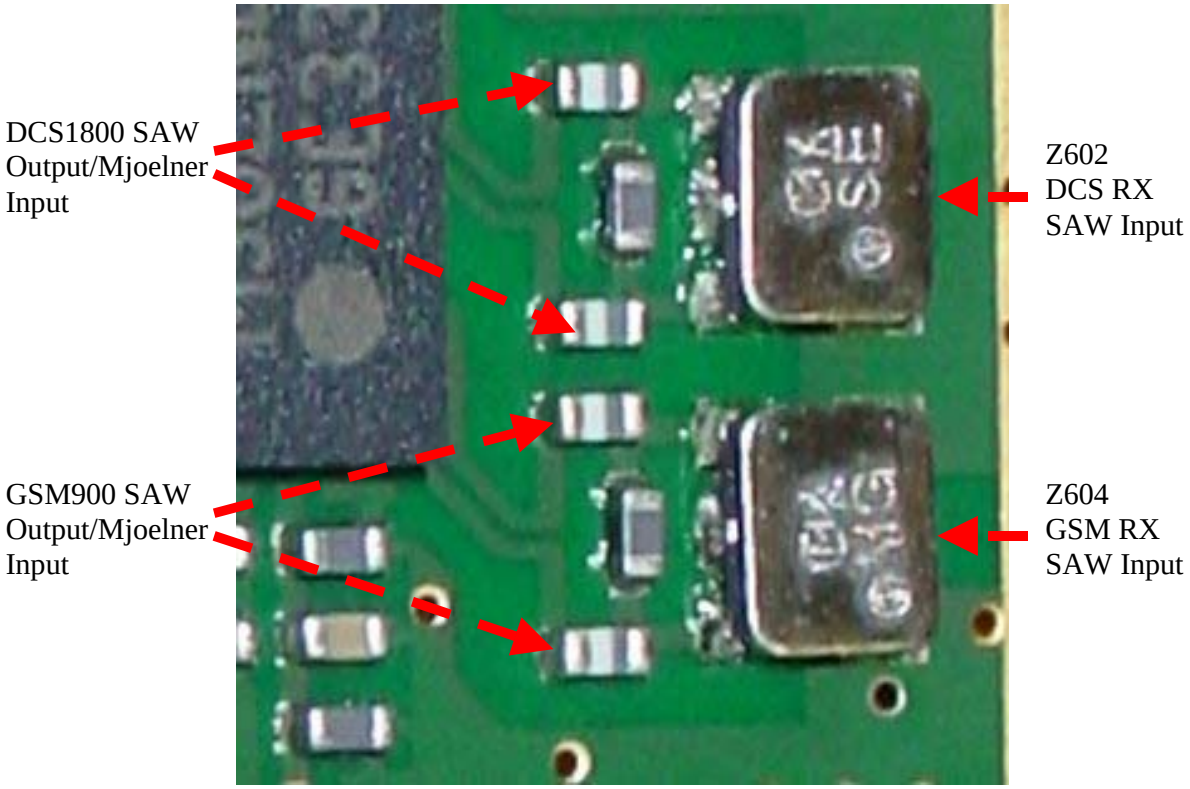


Figure 4: Rx measurement points at Rx SAW filters and Mjoelner RF ASIC



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Measurement points in the transmitter

Figure 5: Tx measurement points inside PA can

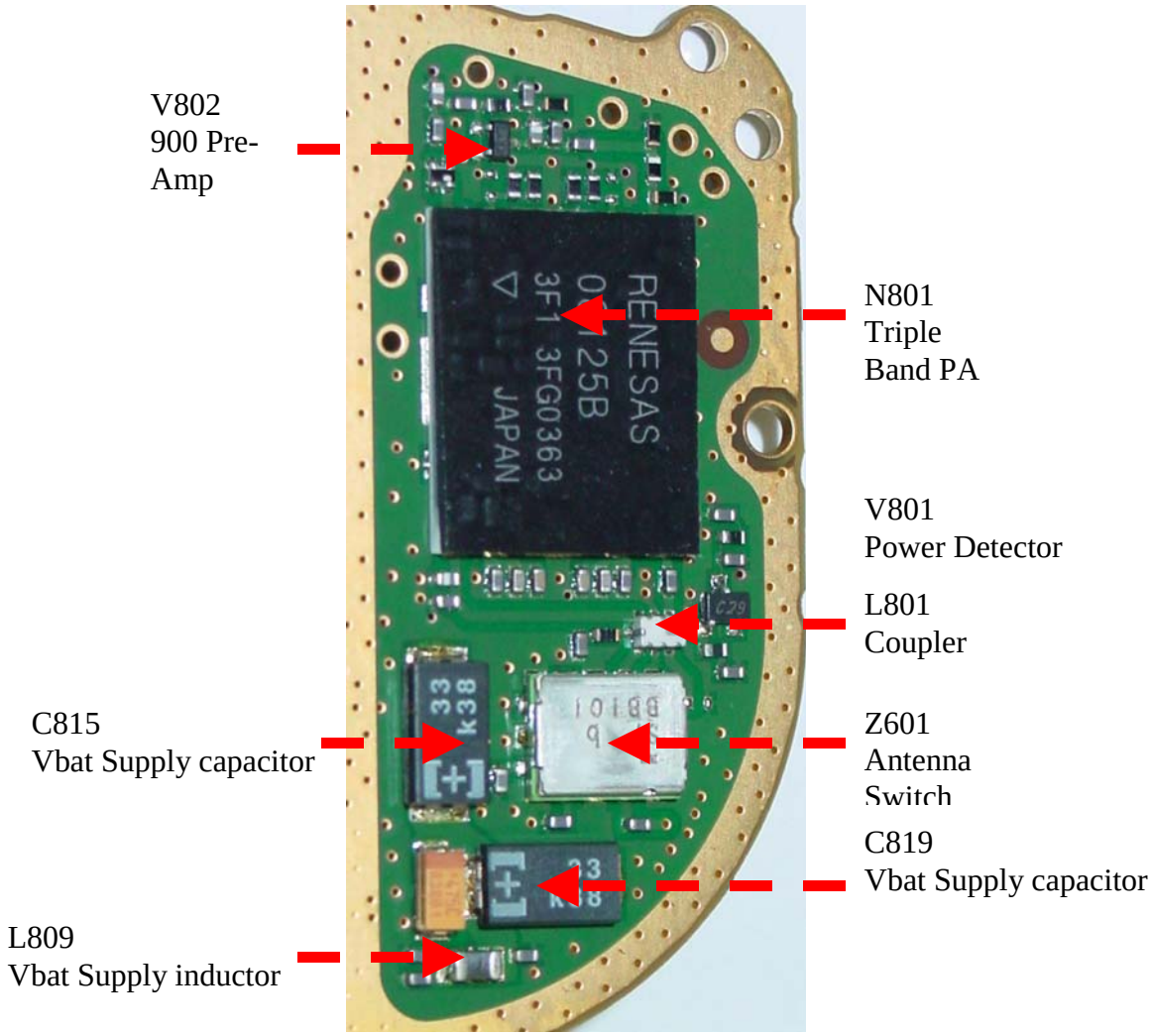

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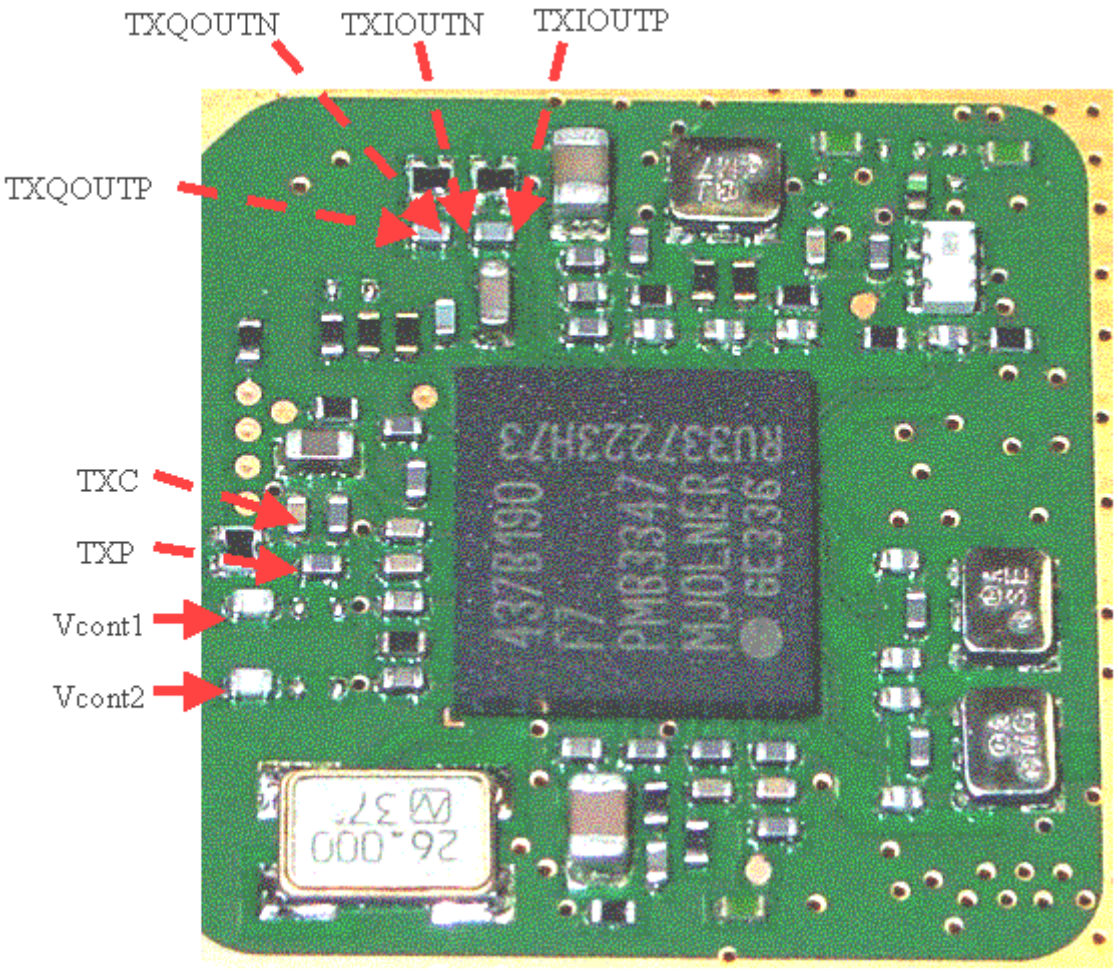
Figure 6: Tx measurement points for TXC, TXP signals



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Receiver

General instructions for RX troubleshooting

Connect the phone to a PC with DAU-9S cable and dongle and follow the following instructions:

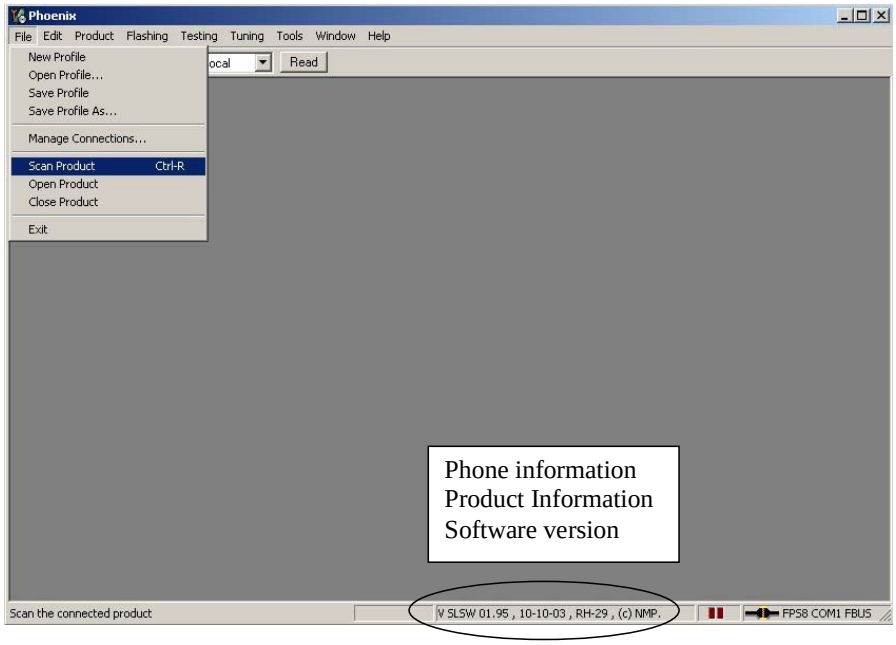
Measuring RX I/Q signals using RSSI reading

Start Phoenix Service Software

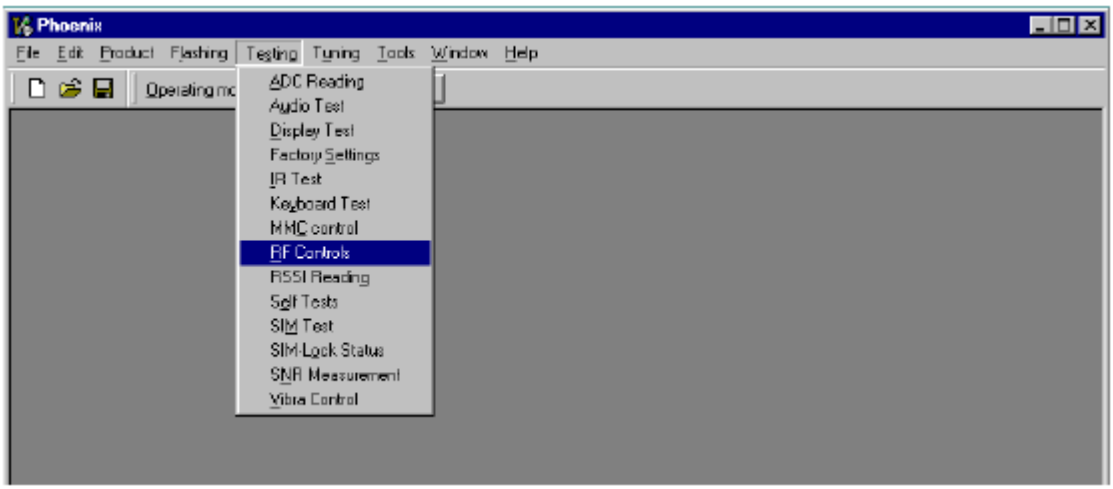
Open the FBUS connection

Select Scan Product Ctrl-R

Wait until phone information shows in the window at the bottom of the screen.



Set operating mode to local mode



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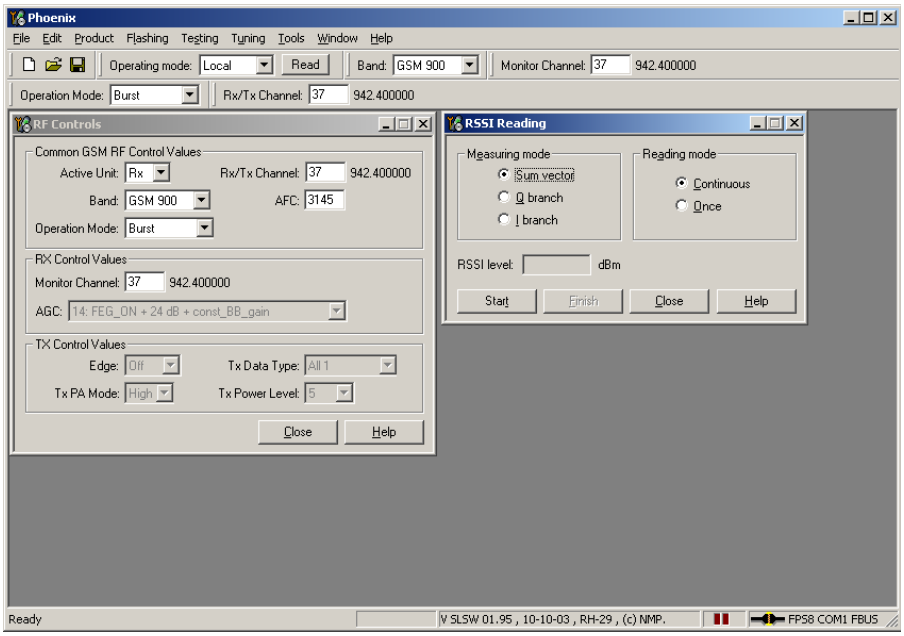
Select	Testing	Alt-S
	RF Controls	R

Wait until the RF Controls window pops up

Select	Band	GSM900 or GSM1800
	Active unit	RX
	Operation mode	Burst
	RX/TX Channel	37 or 700

Select	Testing	Alt-S
	RSSI reading	G

The setup should now look like this:


Phoenix
File Edit Product Flashing Testing Tuning Tools Window Help
Operating mode: Local Read Band: GSM 900 Monitor Channel: 37 942.400000
Operation Mode: Burst Rx/Tx Channel: 37 942.400000
RF Controls
Common GSM RF Control Values
Active Unit: Rx Rx/Tx Channel: 37 942.400000
Band: GSM 900 AFC: 3145
Operation Mode: Burst
RX Control Values
Monitor Channel: 37 942.400000
AGC: 14: FEG_ON + 24 dB + const_BB_gain
TX Control Values
Edge: Off Tx Data Type: All 1
Tx PA Mode: High Tx Power Level: 5
Close Help
RSSI Reading
Measuring mode
Sum vector
Q branch
I branch
Reading mode
Continuous
Once
RSSI level: dBm
Start Finish Close Help
Ready
V SLSW 01.95 , 10-10-03 , RH-29 , (c) NMP.
FPS8 COM1 FBUS

Apply a signal with a frequency of

EGSM900: 942.467 MHz (channel 37 + 67.710kHz offset)

GSM1800: 1842.867 MHz (channel 700 +67.710kHz offset)

and a power level of -80dBm to the RF-connector (remember to compensate for cable attenuation).

In RSSI reading click Start.

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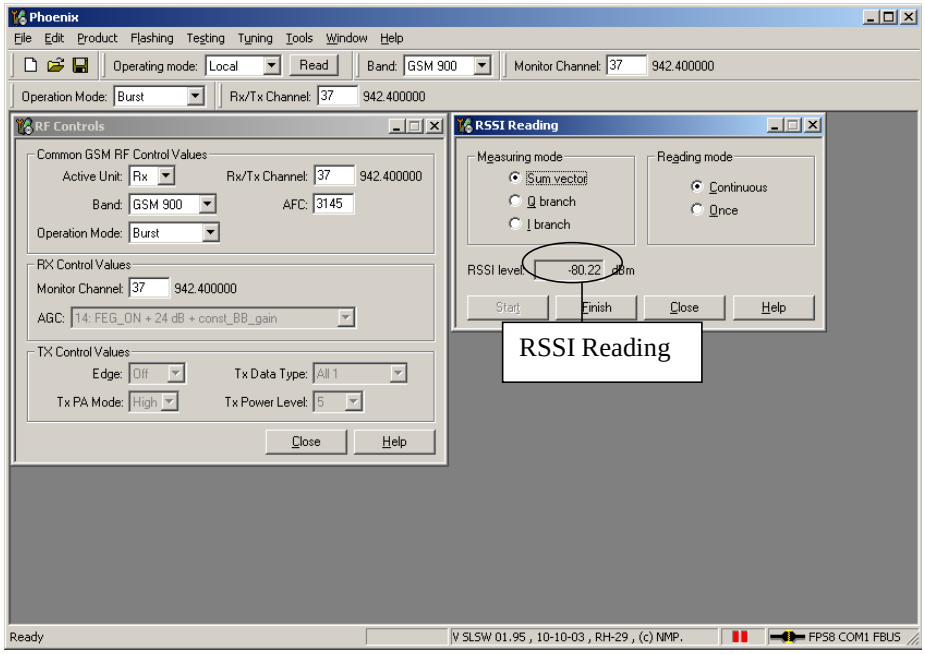
The resulting RSSI level should be –80dBm in each band.



Measuring RX performance using SNR measurement

Start Phoenix Service Software

Open the FBUS connection

Select Scan Product Ctrl-R

Wait until phone information is shown in the lower window at the bottom of the screen.

Set operating mode to local mode

Select Testing Alt-S

RF Controls R

Wait until the RF Controls window pops up

Select Band GSM 900

Active unit RX

Operation mode **Burst**

RX/TX Channel 37

Select Testing Alt-S

SNR Measurement N

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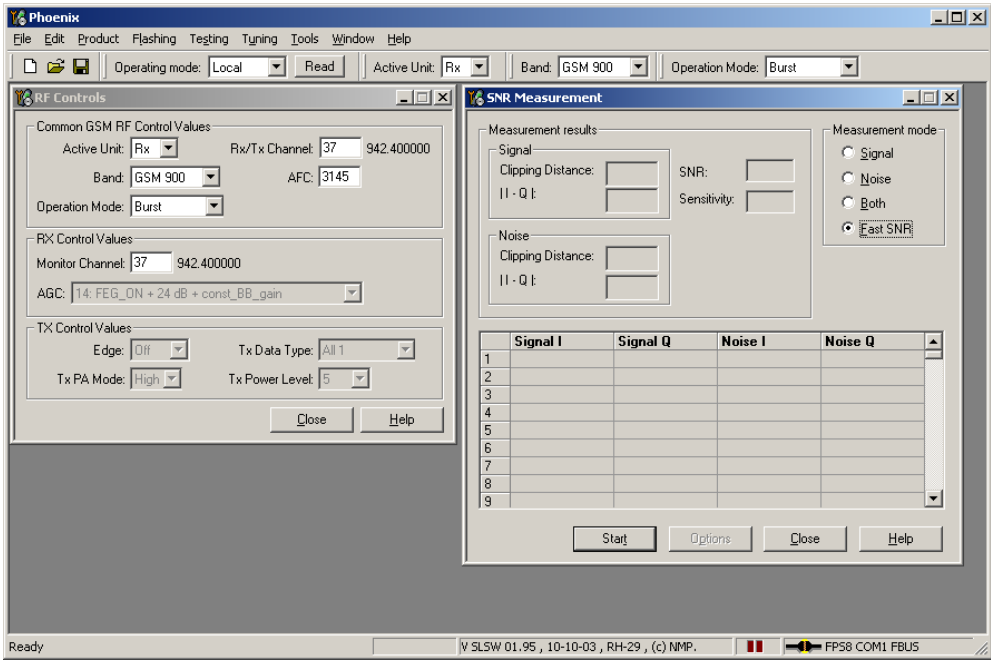
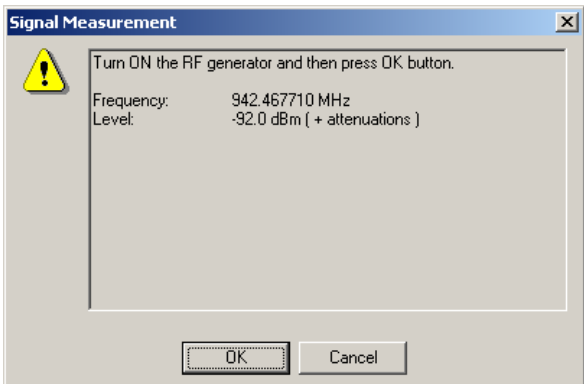
select Fast SNR Radio Button

The setup should now look like this:


Phoenix
File Edit Product Flashing Testing Tuning Tools Window Help
Operating mode: Local Read Active Unit: Rx Band: GSM 900 Operation Mode: Burst
RF Controls
Common GSM RF Control Values
Active Unit: Rx Rx/Tx Channel: 37 942.400000
Band: GSM 900 AFC: 3145
Operation Mode: Burst
RX Control Values
Monitor Channel: 37 942.400000
AGC: 14: FEG_ON + 24 dB + const_BB_gain
TX Control Values
Edge: Off Tx Data Type: All 1
Tx PA Mode: High Tx Power Level: 5
Close Help
SNR Measurement
Measurement results
Signal
Clipping Distance:
I I - Q I:
SNR:
Sensitivity:
Noise
Clipping Distance:
I I - Q I:
Measurement mode
Signal
Noise
Both
Fast SNR
Signal I Signal Q Noise I Noise Q
1 2 3 4 5 6 7 8 9
Start Options Close Help
Ready
V SLSW 01.95 , 10-10-03 , RH-29 , (c) NMP.
FPS8 COM1 FBUS

Choose respective band (GSM900).

Press Start. A window pops up, e.g. for GSM900 band:


Signal Measurement
Turn ON the RF generator and then press OK button.
Frequency: 942.467710 MHz
Level: -92.0 dBm (+ attenuations)
OK
Cancel

Connect an external signal generator to the RF connector of the phone and set the generator as told in the window, taking care for external cable losses.

Press ok and the window closes.

Read the SNR result. SNR should be: EGSM900 >20dB

GSM1800 >18dB

Measuring front end power levels using spectrum analyzer

Spectrum Analyzer (SA) level values depend on the probe type and should be validated using a good sample.

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The levels that are given here are measured using a resistive probe (50Ohm semi-rigid cable).

Start Phoenix Service Software

Open the FBUS connection

Select	Scan Product	Ctrl-R

Wait until phone information shows in the lower right corner of the screen.

Set operating mode to local mode

Select	Testing	Alt-S
	RF Controls	R

Wait until the RF Controls window pops up

Select	Band	GSM 900 or DSC1800
	Active unit	RX
	Operation mode	**Continuous**
	RX/TX Channel	37 or 700

Please refer to the troubleshooting chart for proper levels at different test points.

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Receiver troubleshooting

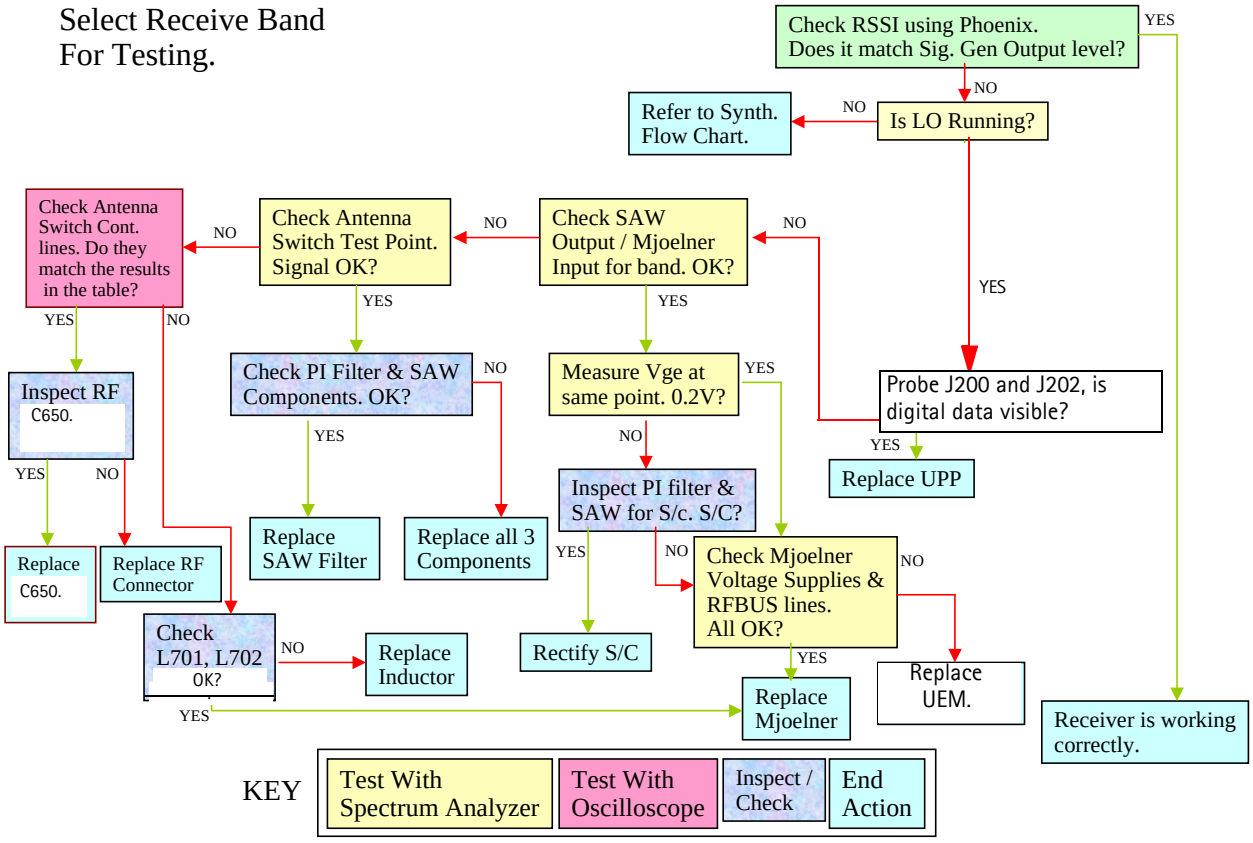
Set up Phoenix as if doing RSSI measurements.

Ascertain which Rx band is faulty.

Refer to Rx troubleshooting flowchart.

Set signal generator frequency to 942.46771MHz for EGSM900 or 1847.86771MHz for DCS1800.

Set signal generator amplitude to -60dBm.



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GSM900 Transmitter

General instructions for GSM900 TX troubleshooting

Apply an RF-cable to the RF-connector to allow the transmitted signal to act normally. The RF-cable should be connected to measurement equipment (GSM Test equipment, Power meter, Spectrum Analyzer, or similar). Be sure to use at least a 10-dB attenuator, otherwise the analyzer may be overloaded.

Connect the phone to a PC with DAU-9P cable and dongle and follow the following instructions:

Connect the phone to a power supply (3.5... 4V).

Open Phoenix and select Fbus connection.

Select 'File' and 'Scan Product' from the pull down menus.

Select 'Testing', 'RF controls' from the pull down menu.

Chose Transmit Band for testing, Use the automatically selected channel.

Set Operation Mode to 'Burst'.

Choose the Power level you want the phone to operate at.

Set spectrum analyzer center frequency, 897.4MHz for EGSM900 and 1747,8MHz for DCS1800 and set Span to 1MHz.

Set Amplitude of spectrum analyzer reference level to one that you can clearly see the transmit pulse according to the kind of test probe you are using.

Diagnose as per troubleshooting flowchart.

Note:Be careful when selecting the operation mode, if 'Continuous' is selected prolonged transmission may damage the phone

TX Path of the transmitted GSM900 signal

For easy error tracing it is important to know the signal path of the GSM900 transmitter. The components can be grouped into blocks and drawn as shown below. Note that the following picture shows both GSM900 transmitter (bottom) and GSM1800 transmitter

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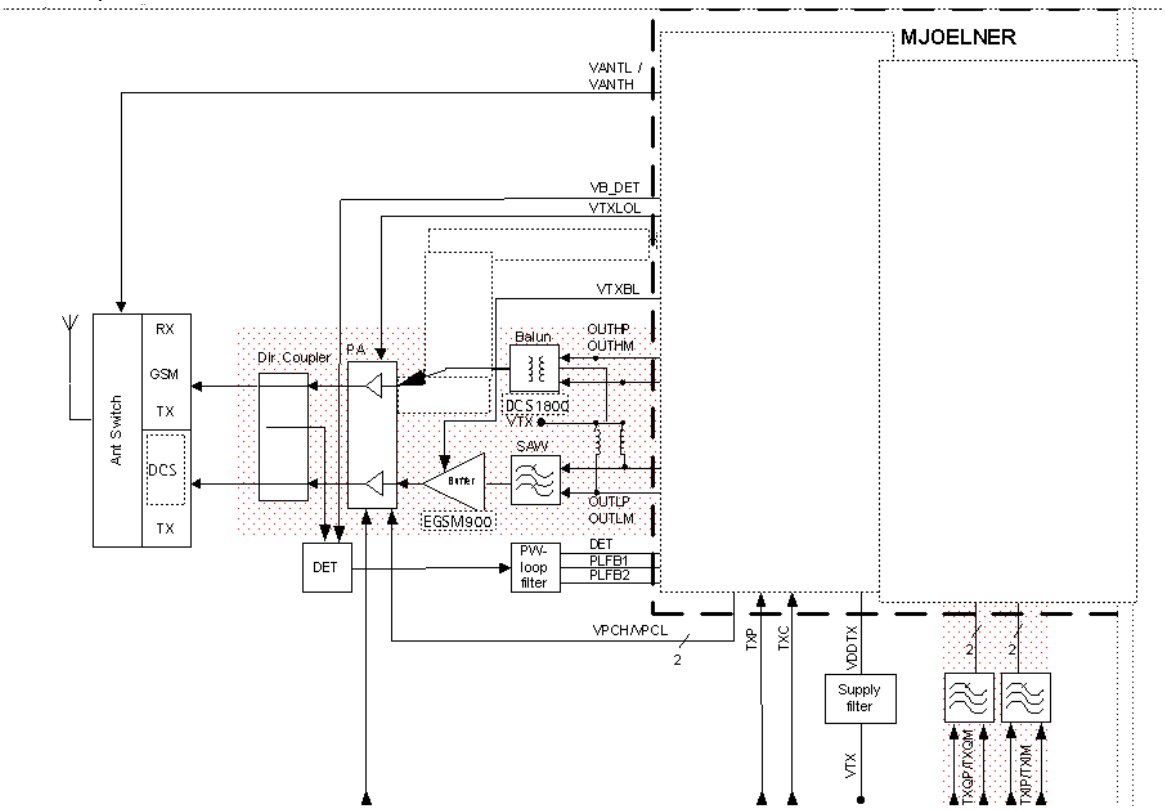
(top).



GSM900 TX path of Mjoelner RF ASIC

The balanced TX signal is provided by the base band and is coming to the Mjoelner RF ASIC. The TX paths of the Mjoelner RF ASIC include mainly two RF modulators for up-conversion of the base band signals, one for GSM900 and one for GSM1800. The base band signal is modulated with the LO signal corresponding to the wanted TX channel. The GSM TX output of the Mjoelner RF ASIC is a balanced signal.

From the output of the Mjoelner RFASIC the signal is fed through the 900 TX SAW filter (Balanced to single ended), the 900 MHz buffer, and a 5 dB pad to the PA input.

GSM900 TX path of the Power Amplifier (PA)

The PA GSM900 part has a minimum stable output power of app. 35 dBm. Voltage supply is coming directly from the Battery connectors.

The GSM900 output is controlled by the power control loop. From the GSM900 output of the PA the RF signal is fed through the directional coupler (one of the power control loop components) to the antenna switch.

Antenna Switch (TX/RX switch)

The antenna Switch works as a diplexer for the RX and TX signals. Moreover, it suppresses the TX harmonics generated by the PA. The antenna switch is controlled by the Mjoelner RF ASIC using the control signals Vcont1 and Vcont2. The following table

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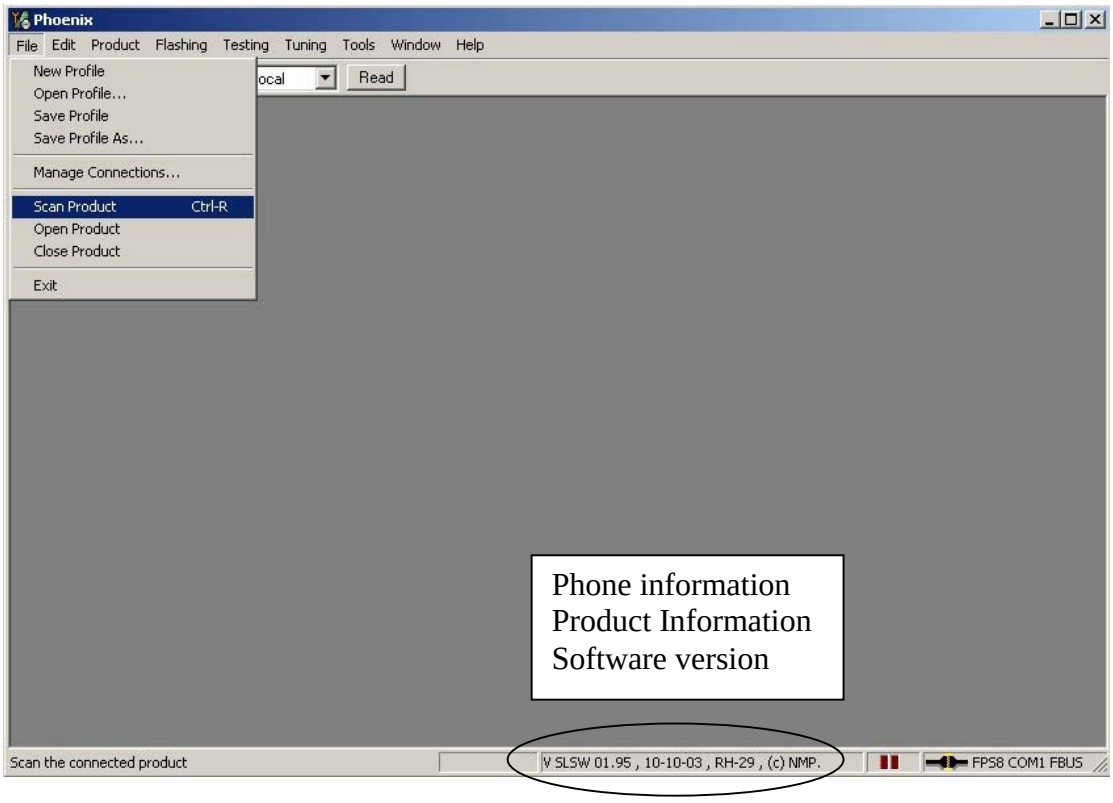
shows the possible different states.

Vcont1 [Volt]	Vcont2 [Volt]	900 Rx	DCS Rx	900 Tx	DCS Tx
0	0	X			
0	0		X		
0	2.7			X	
2.7	0				X



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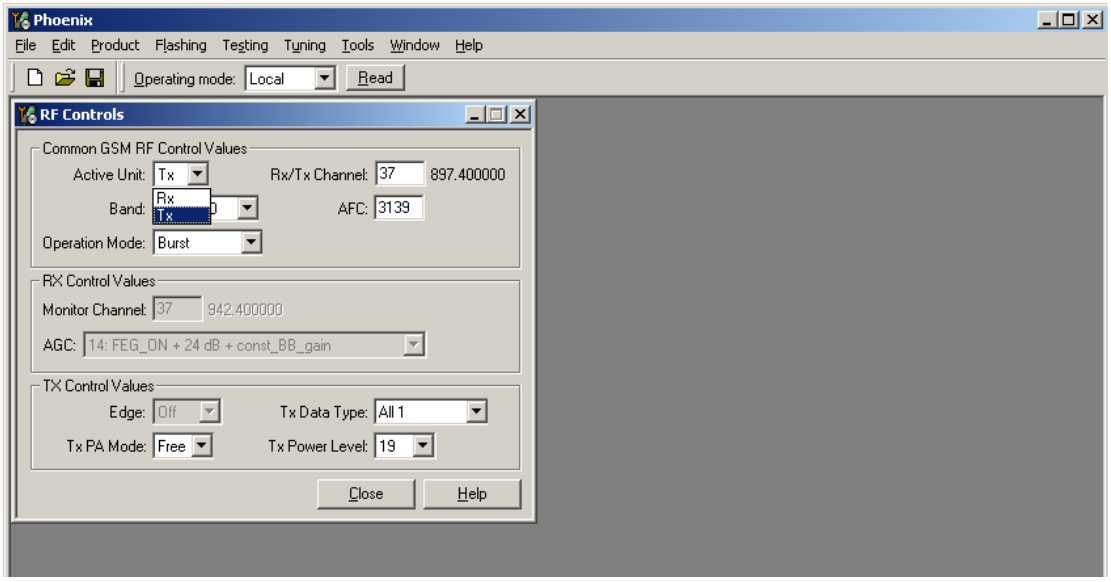

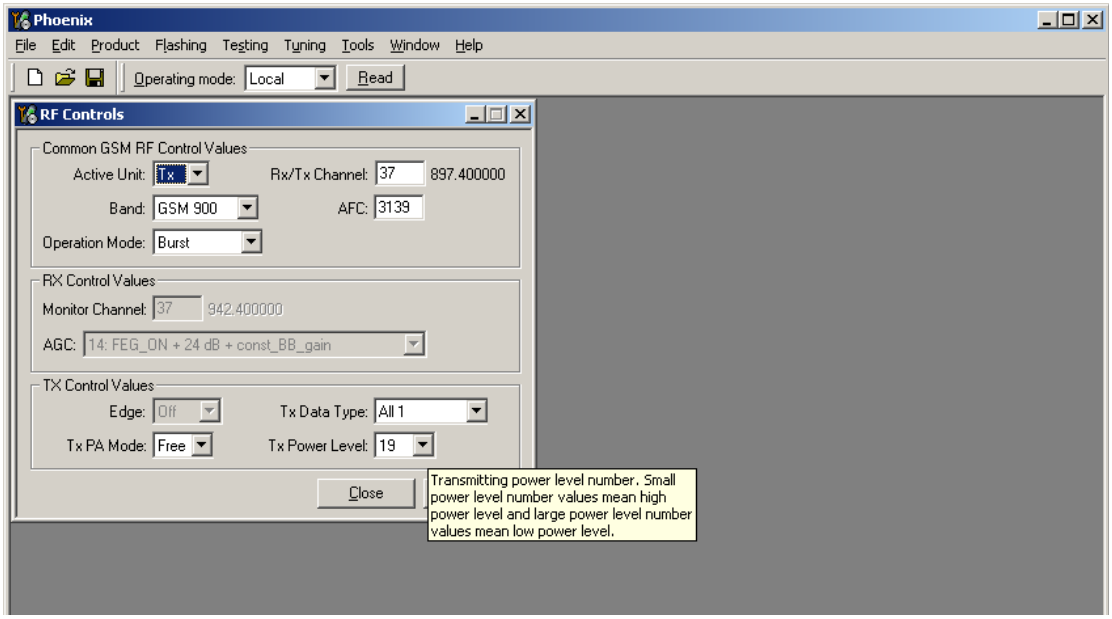
Phoenix
File Edit Product Flashing Testing Tuning Tools Window Help
Operating mode: Local
Read
RF Controls
Common GSM RF Control Values
Active Unit: Tx
Rx/Tx Channel: 37
897.400000
Band: GSM 900
AFC: 3139
Operation Mode: Burst
RX Control Values
Monitor Channel: 37
942.400000
AGC: 14: FEG_ON + 24 dB + const_BB_gain
TX Control Values
Edge: Off
Tx Data Type: All 1
Tx PA Mode: Free
Tx Power Level: 19
Close
Transmitting power level number. Small power level number values mean high power level and large power level number values mean low power level.

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Figure 7: TX Digital I & Q Test Points

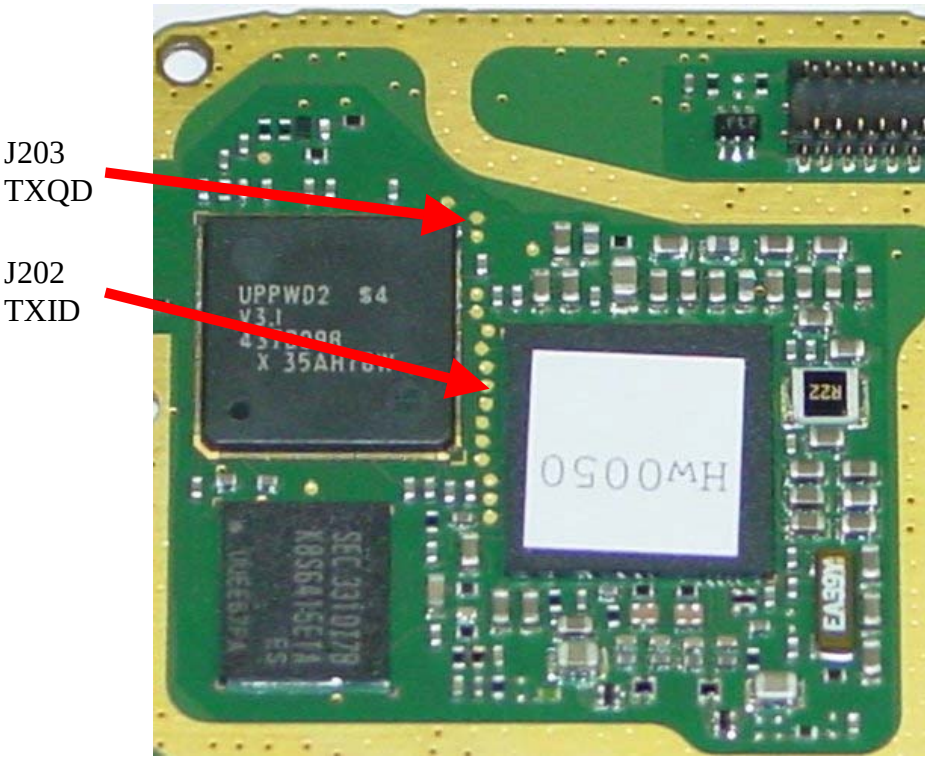

Figure 8: TX Digital I & Q Data, J202 and J203

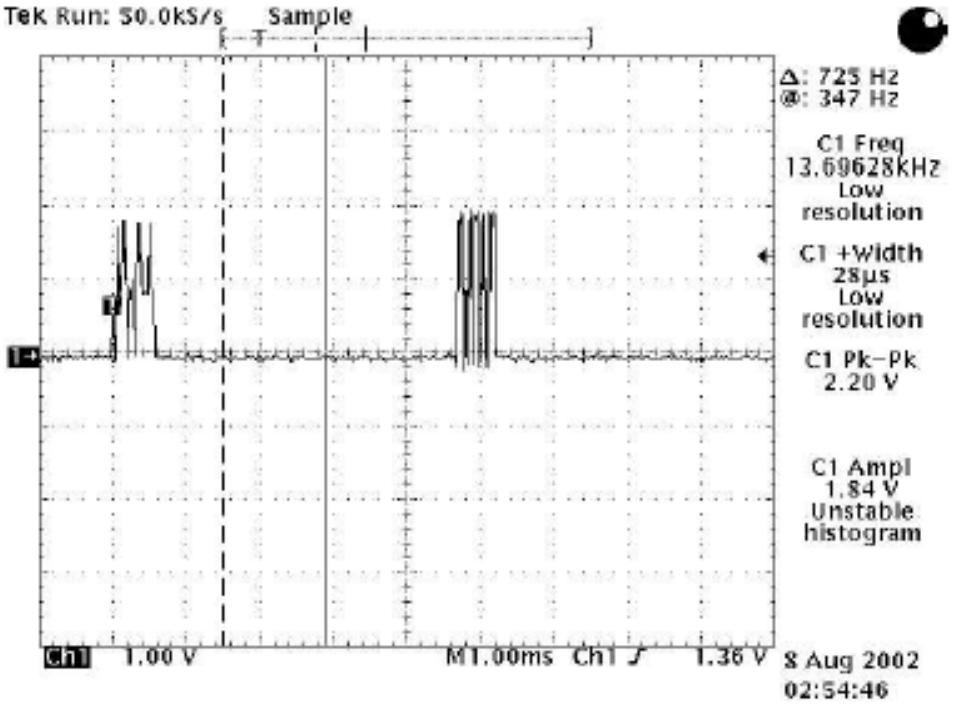

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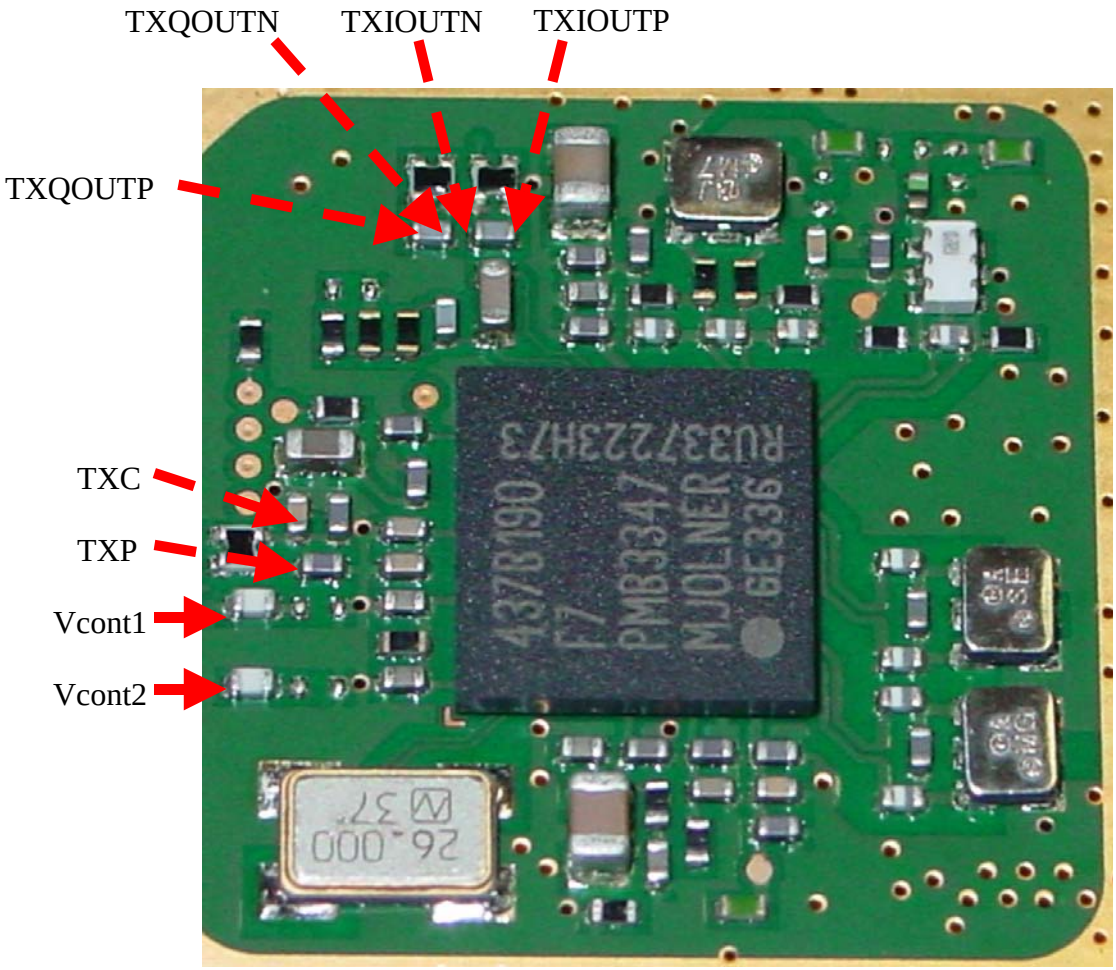
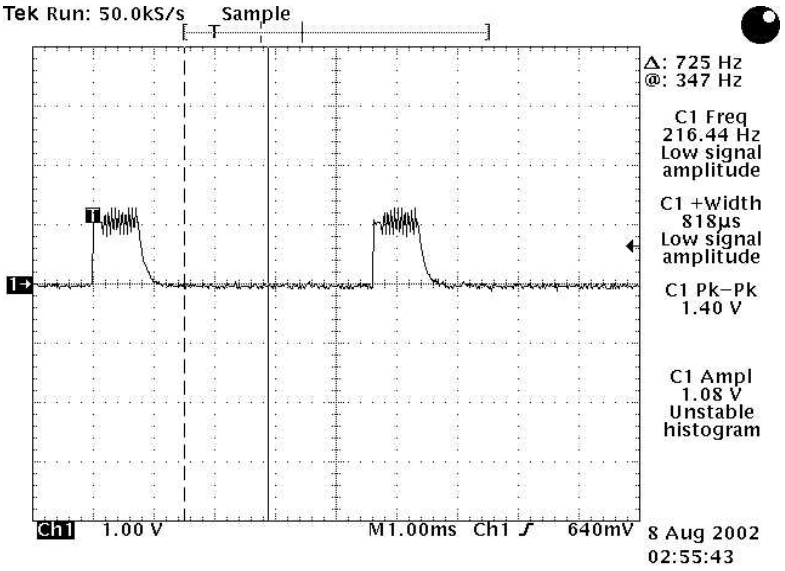
Figure 9: Mjoelner Can Test Points



TX Analog I & Q Data, C715 & C716



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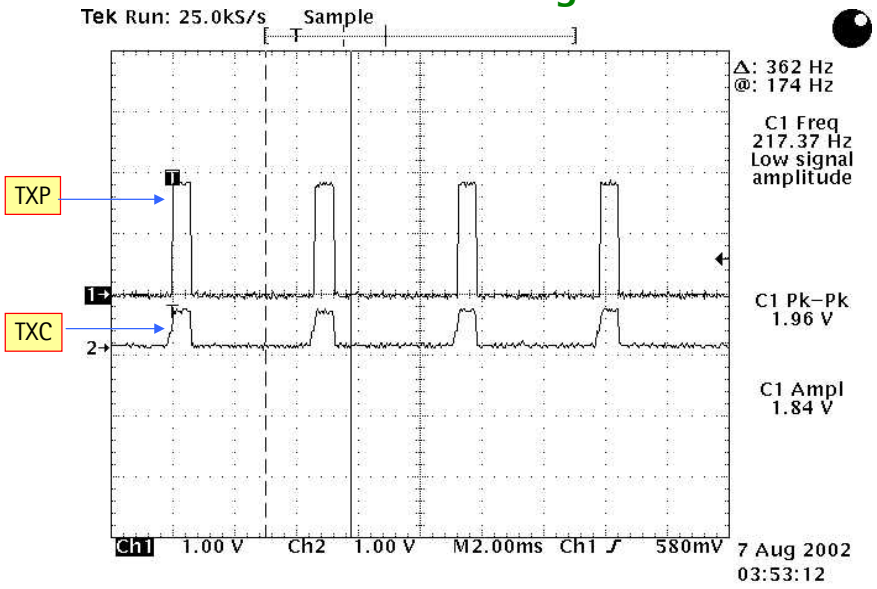
TXP & TXC Lines during Transmission



TXP / TXC Mask

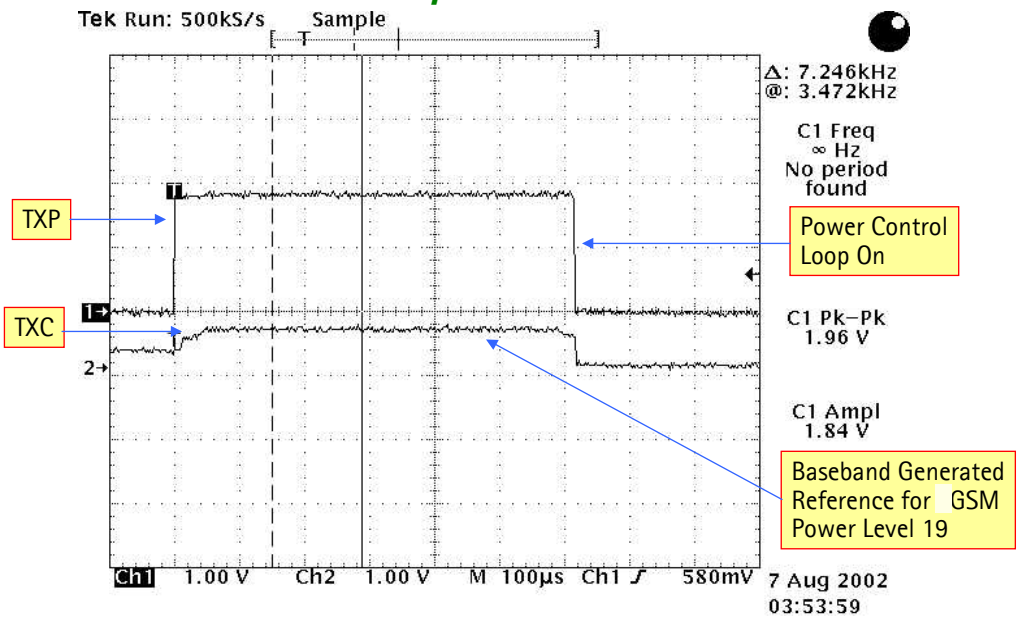


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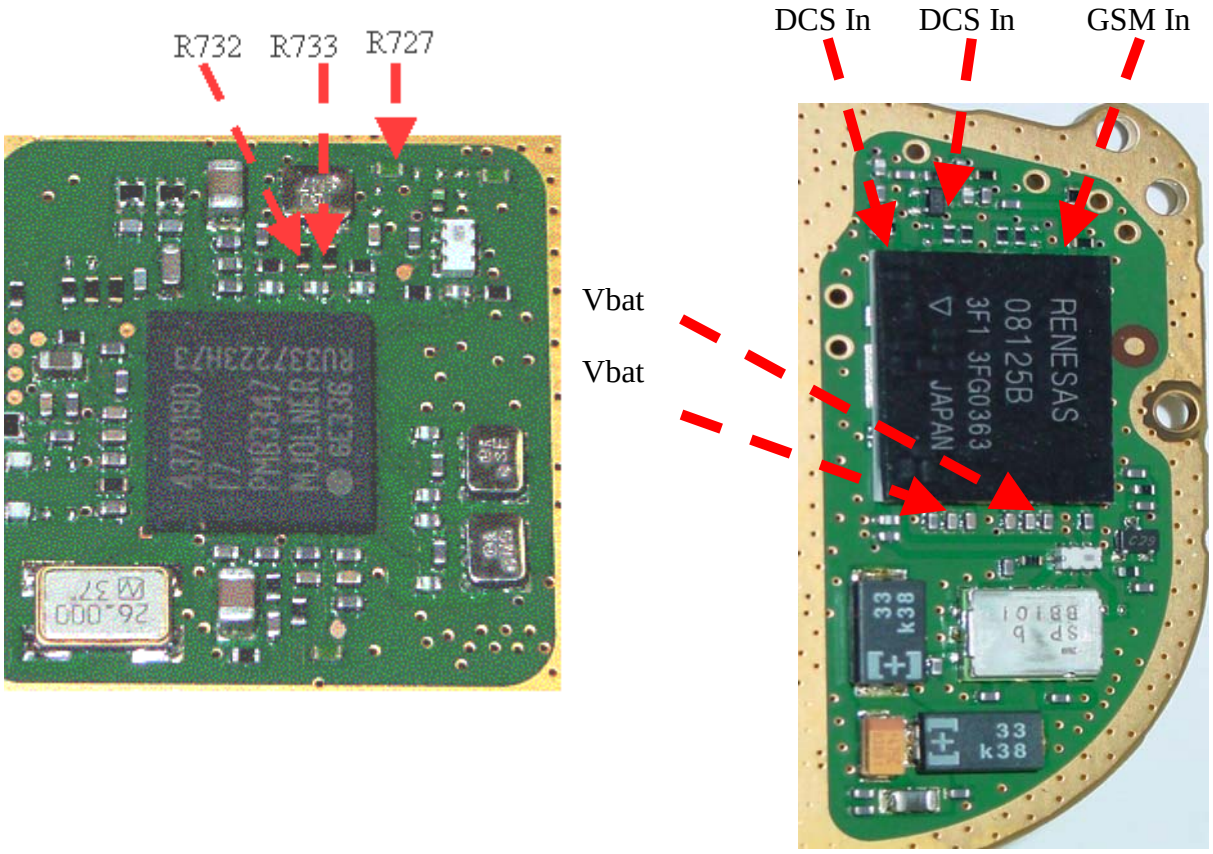
Figure 10: GSM900 TX Test Points



VTXB_900 (900 V802 Pre-Amp Biasing Waveform)

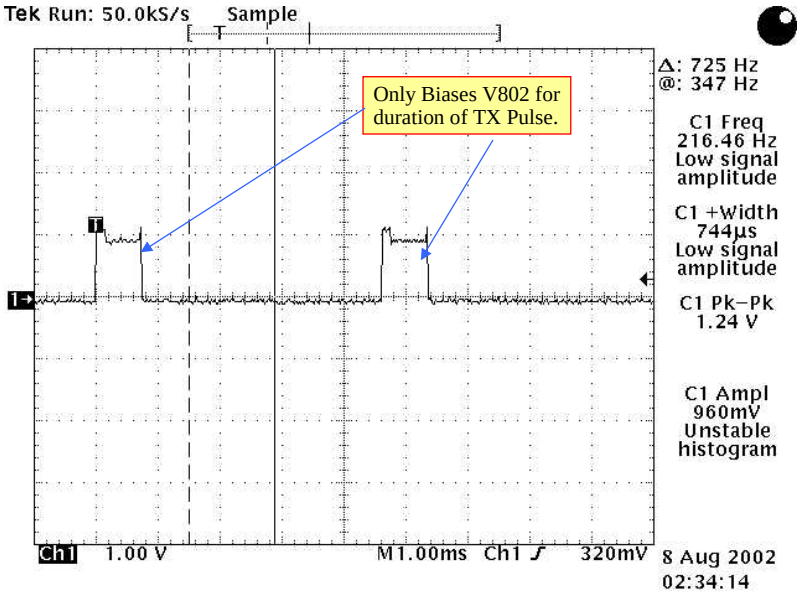


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Figure 11: 900 Tx waveform, burst, pwr level 19

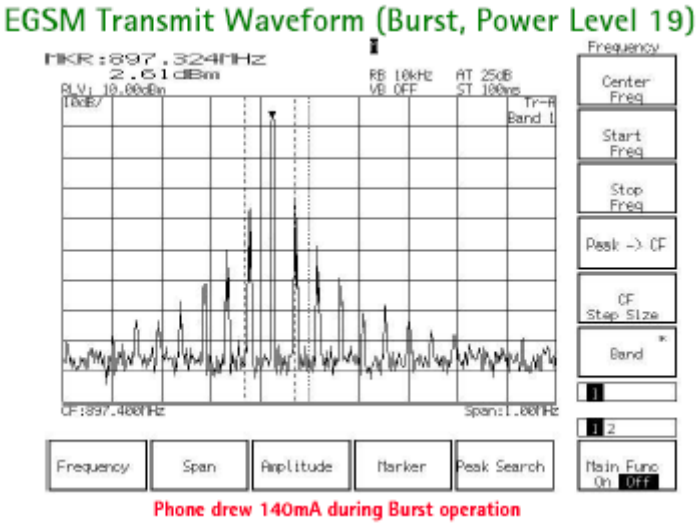
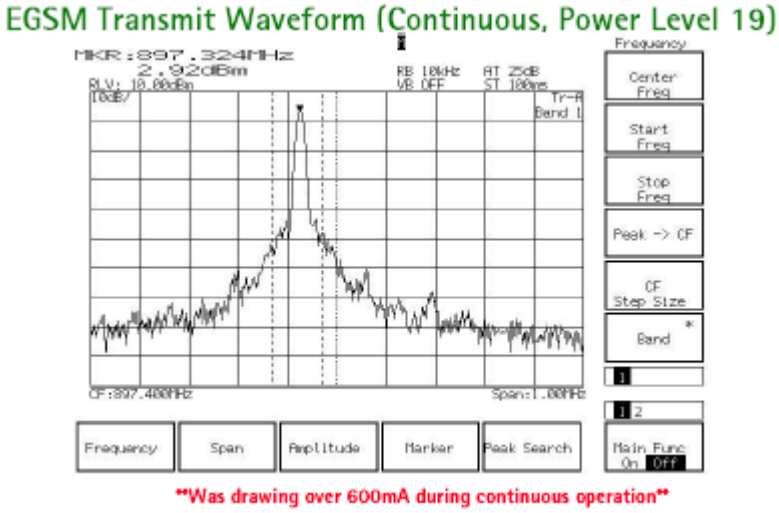


Figure 12: 900 Tx waveform, continuous, pwr level 19



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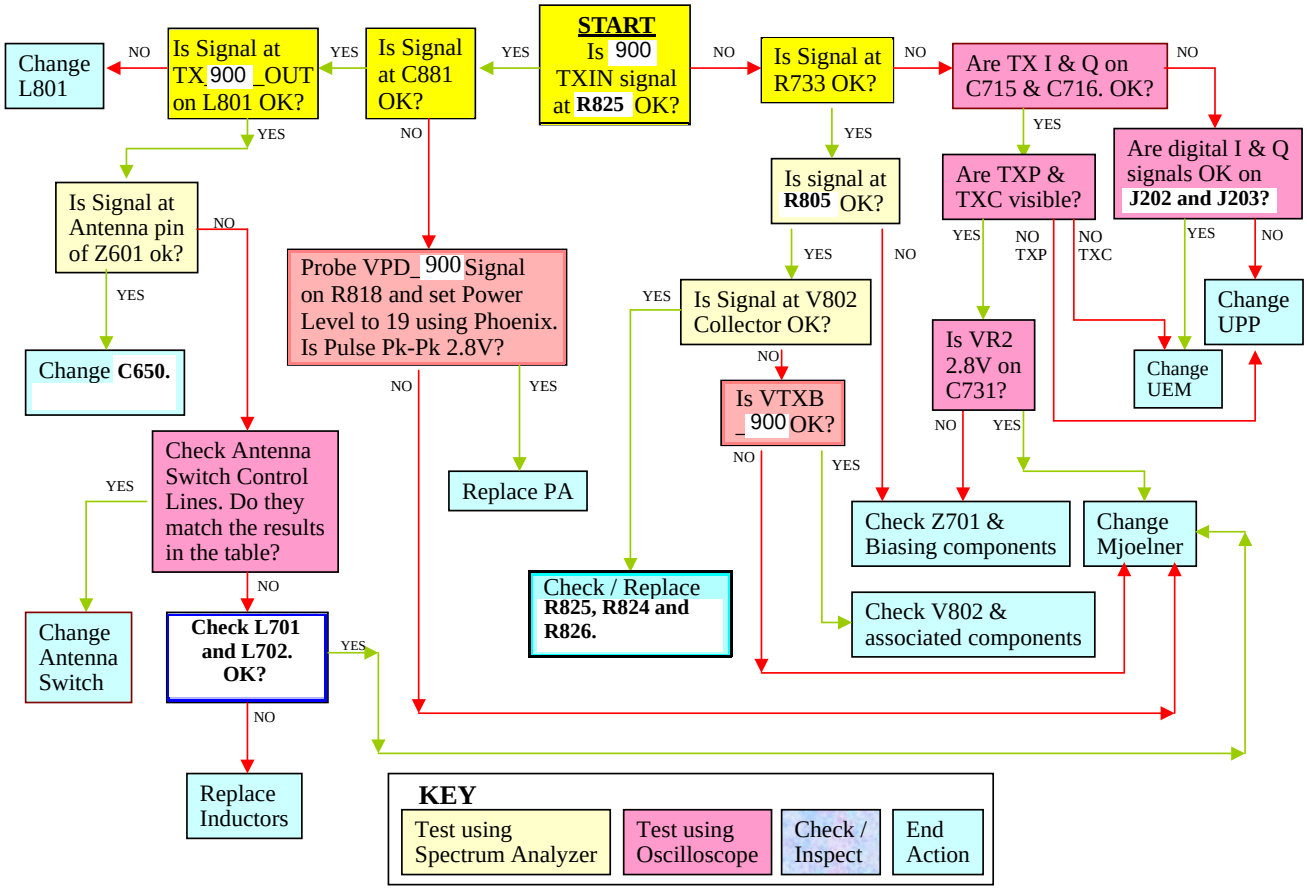
900 Tx troubleshooting flowchart

THE FIRST FLOW DIAGRAM ASSUMES THE FOLLOWING:

- Phoenix has been set up as shown in the following screen (the Tx power level may be increased using Phoenix if it makes the Tx pulse easier to see).
- Relevant components have been visually inspected for orientation, placement, etc.
- The transmit signal has been checked with a spectrum analyzer at RF connector, X602 and was found to be too low or non-existent.
- The VCO is running correctly.
- The power amplifier is getting a correct VBATRF supply via L809.
- Mjoelner's supply voltages VR1A, VR2, VR3, VR4, VR5 & VR7 are all working correctly.


START
Is 900 TXIN signal at R825 OK?
Is Signal at C881 OK?
Is Signal at TX 900 _OUT on L801 OK?
Change L801
Is Signal at Antenna pin of Z601 ok?
Change C650.
Check Antenna Switch Control Lines. Do they match the results in the table?
Change Antenna Switch
Check L701 and L702. OK?
Replace Inductors
Probe VPD_900 Signal on R818 and set Power Level to 19 using Phoenix. Is Pulse Pk-Pk 2.8V?
Replace PA
Is Signal at R733 OK?
Is signal at R805 OK?
Is Signal at V802 Collector OK?
Check / Replace R825, R824 and R826.
Is VTXB _900 OK?
Check V802 & associated components
Are TX I & Q on C715 & C716. OK?
Are TXP & TXC visible?
Are digital I & Q signals OK on J202 and J203?
Change UPP
Change UEM
Is VR2 2.8V on C731?
Check Z701 & Biasing components
Change Mjoelner
KEY
Test using Spectrum Analyzer
Test using Oscilloscope
Check / Inspect
End Action

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GSM1800 Transmitter

General instructions for GSM1800 TX troubleshooting

Apply an RF-cable to the RF-connector to allow the transmitted signal to act as normal. RF-cable should be connected to measurement equipment (GSM Test equipment, Power meter, Spectrum Analyzer, or similar).

DCS1800 Tx troubleshooting flowchart

The following diagram assumes the following:

- Phoenix has been set up as shown previously (selecting DCS1800 in the RF control box).
- Relevant components have been visually inspected for orientation, placement etc.
- The Transmit Signal has been checked with a Spectrum Analyzer at the RF connector, X602 and was found to be low or non-existent.
- The VCO is running correctly.
- The Power Amplifier is getting a correct VBATRF supply via L809.
- Mjoelner's supply voltages VR1A, VR2, VR3, VR4, VR5 & VR7 are all working correctly.

Path of the transmitted 1800 signal

For easy error tracking it is important to know the signal path of the GSM1800 transmitter. The components can be grouped into blocks and drawn as shown below. Note that the picture shows both EGSM900 transmitter (bottom) and GSM1800 transmitter (top).

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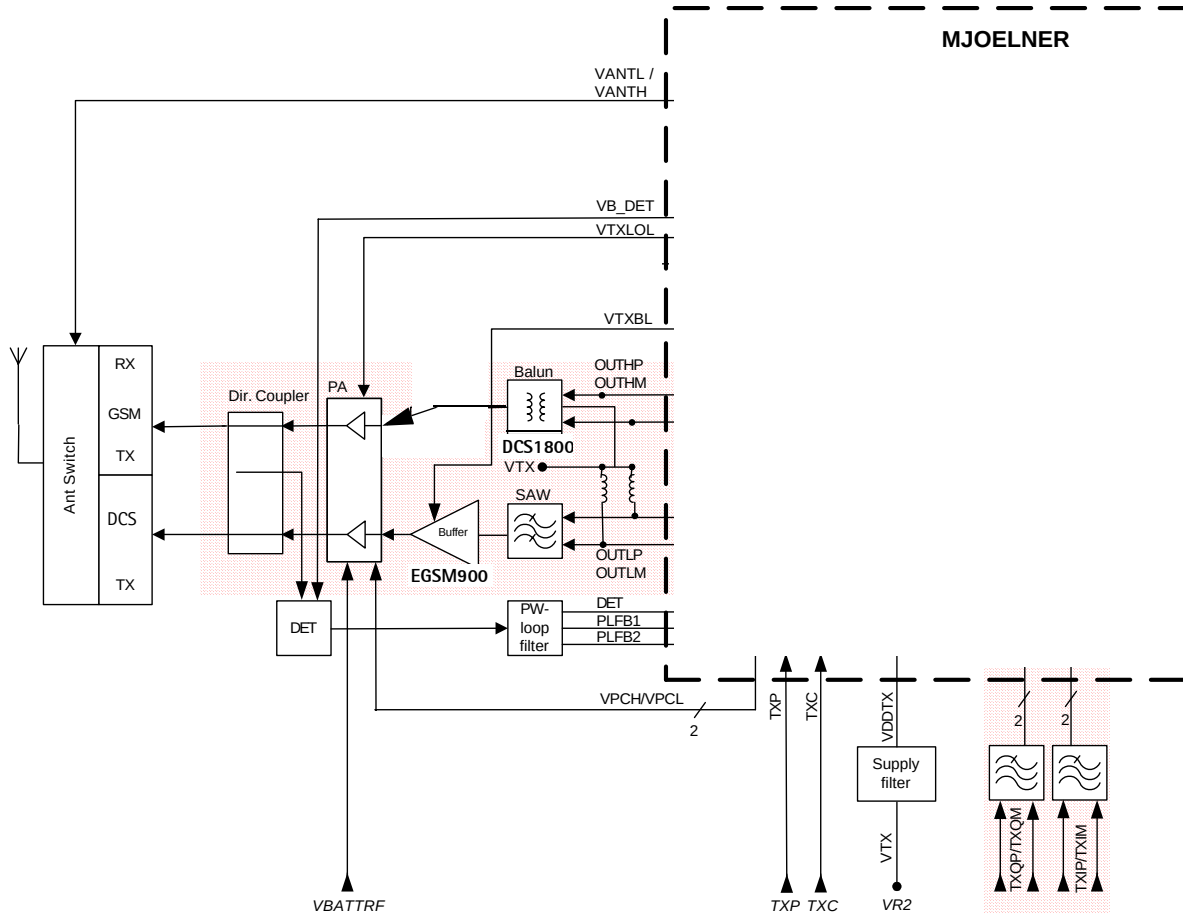

The path of Mjoelner RF ASIC

The balanced TX signal from base band is coming to Mjoelner RF ASIC. The GSM1800 path includes a RF modulator for GSM1800. The BB signal is up-converted with the LO signal corresponding to the wanted TX channel. The GSM1800 TX output of Mjoelner is a balanced signal.

From the output of Mjoelner the signal is fed through the Balun T701 (Balanced to single ended) and a 3 dB pad.

The path of the PA

The GSM1800 part of the PA has a maximum output of approximately 33dBm. The supply is coming directly from the Battery connectors.

The output is controlled by the power control loop. From the output of the PA the signal goes through the directional coupler (one of the power control loop components) to the Antenna Switch.

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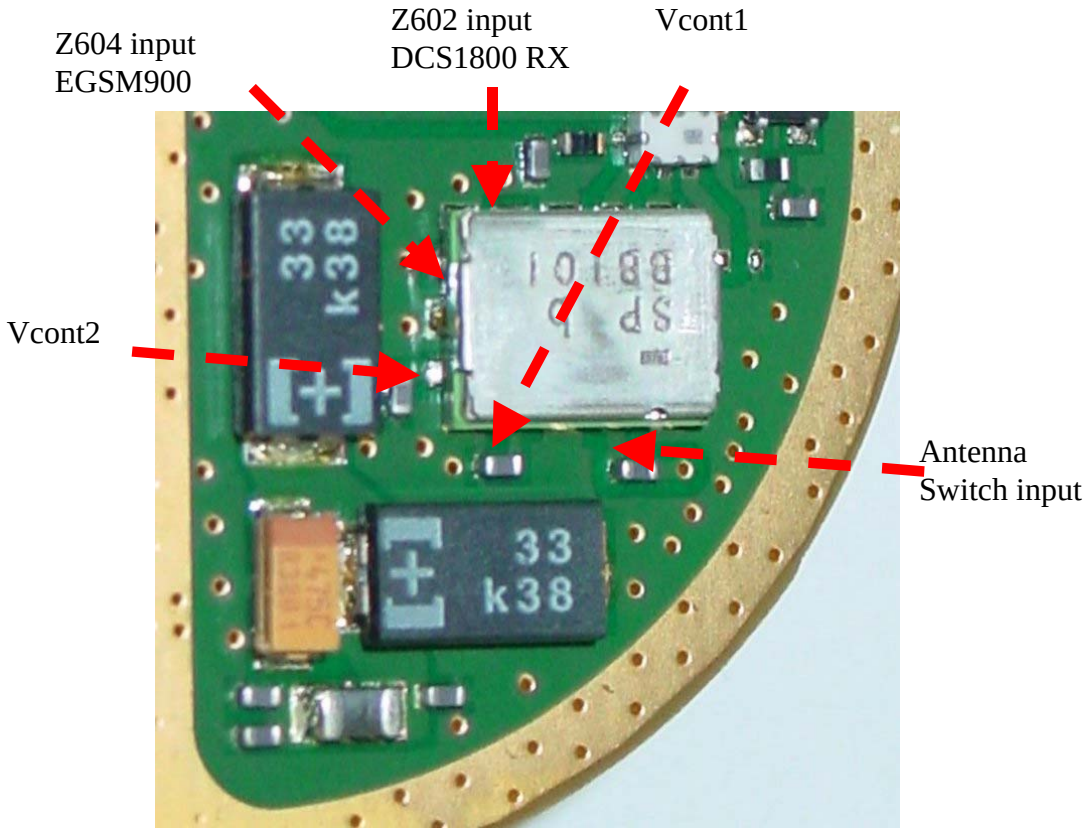
Antenna Switch

The Antenna Switch works as a diplexer between RX and TX Bands. Moreover, it partly suppresses the harmonics generated by the PA. Mjoelner RF ASIC controls the antenna switch by two voltages Vcont1 and Vcont2. The following table shows the different states.

Vcont1 [Volt]	Vcont2 [Volt]	EGSM RX	DCS RX	EGSM TX	DCS TX
0	0	X			
0	0		X		
0	2.7			X	
2.7	0				X

Figure 13: Antenna Switch Test Points



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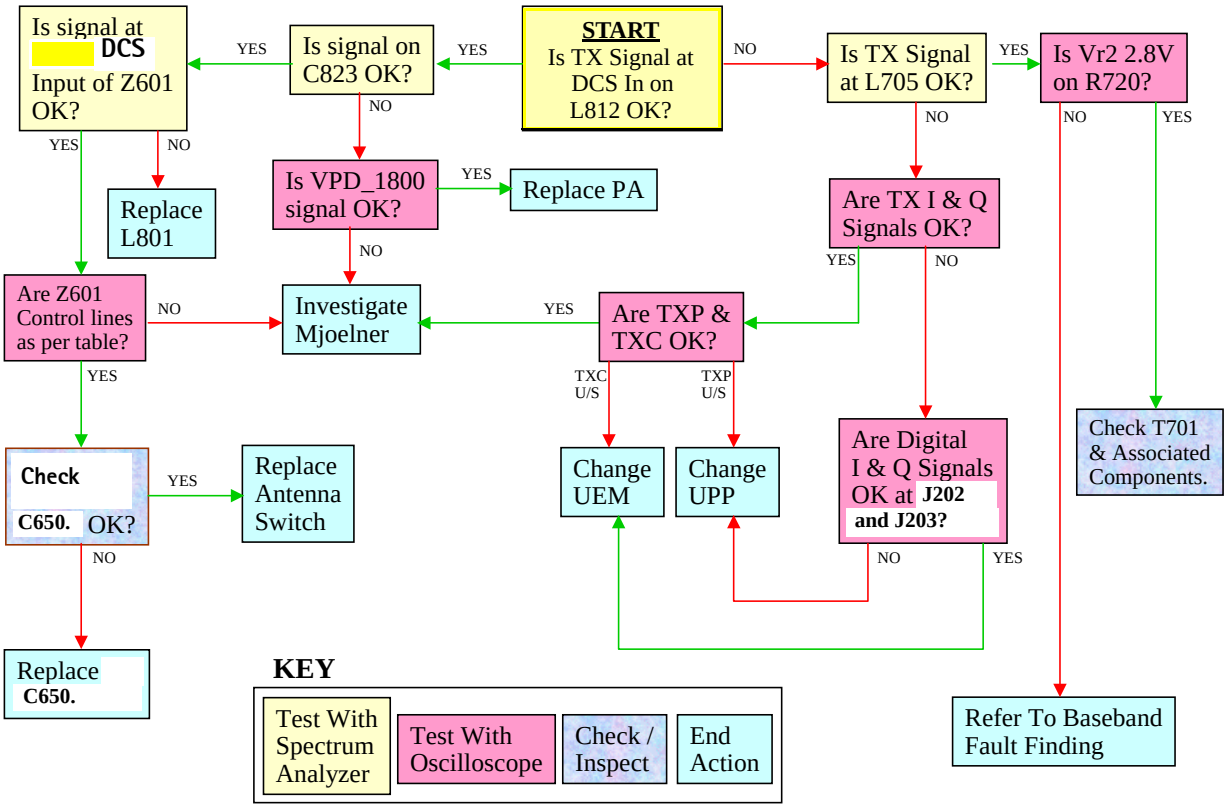
Troubleshooting chart for GSM1800 transmitter



If the Tx output is too high, then it is most likely that there is a problem within the Power Control loop.

Mjoelner is receiving the Reference TXC from Baseband and not getting any feedback from DET to compare with TXC. The result is that Mjoelner drives VDP_900/VPD_1800 high to try and increase the power output so that the DET signal is matching TXC. With a break in the Power Control loop, the DET signal never reaches Mjoelner so it assumes that the PA is not outputting enough power so it tries to compensate by increasing the gain.

When checking the Power Control loop, make sure that VBD is pulsing at 2.8V Peak to Peak. Check the DET pulse at Mjoelner input on R706.

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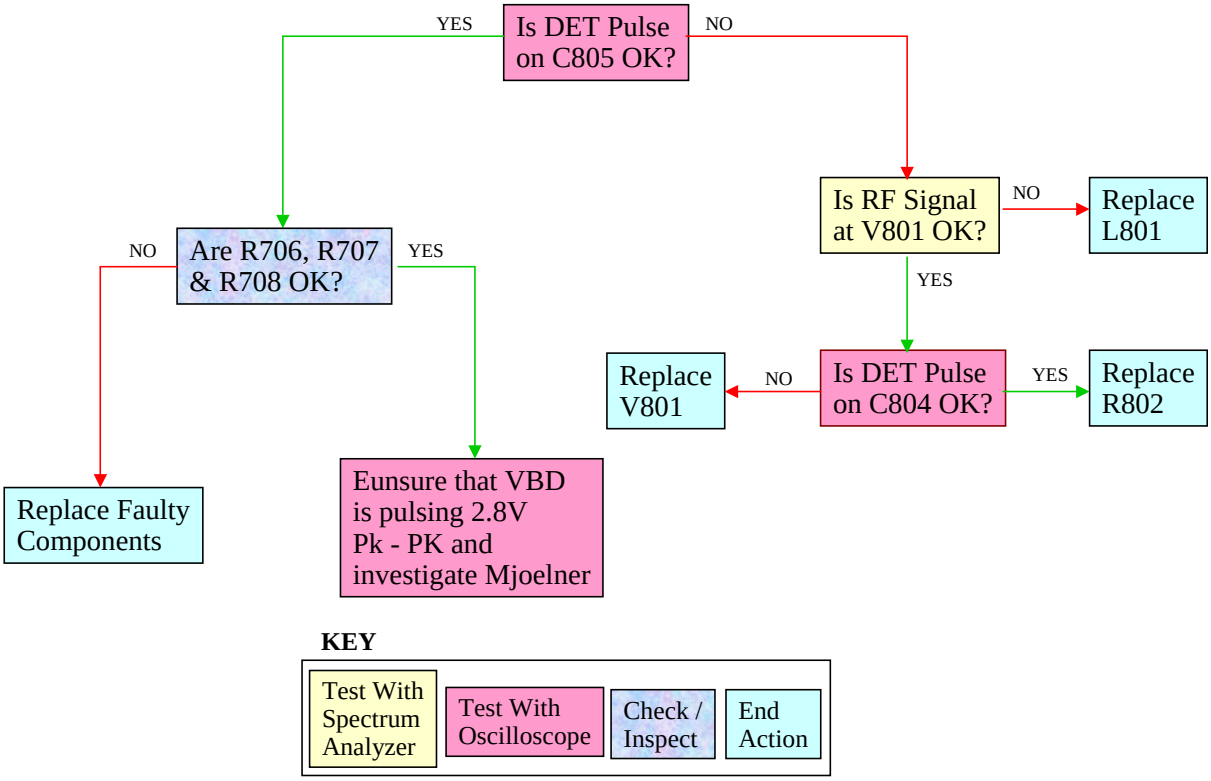
This case is the same for EGSM900 & DCS1800.



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RH-29 Synthesizer

There is only one PLL synthesizer generating frequencies for both Rx and Tx for all three bands. VCO frequency is divided by 2 or by 4 in Mjoelner depending on which band is active.

General instructions for synthesizer troubleshooting

Connect the phone to a PC with DAU-9P cable and dongle and follow these instructions:

Start Phoenix Service Software (dongle needed):

Select	Scan Product	Ctrl-R

Wait until phone information shows in the lower right corner of the screen.

Set operating mode to local mode.

Start RF Control window:

Select	Testing	Alt-S
	RF Controls	R

Wait until the RF Controls window pops up

Set the synthesizer to the following mode:

Select	Band	GSM900 or DCS1800
	Active unit	RX
	Operation mode	Continuous
	RX/TX Channel	37 or 700

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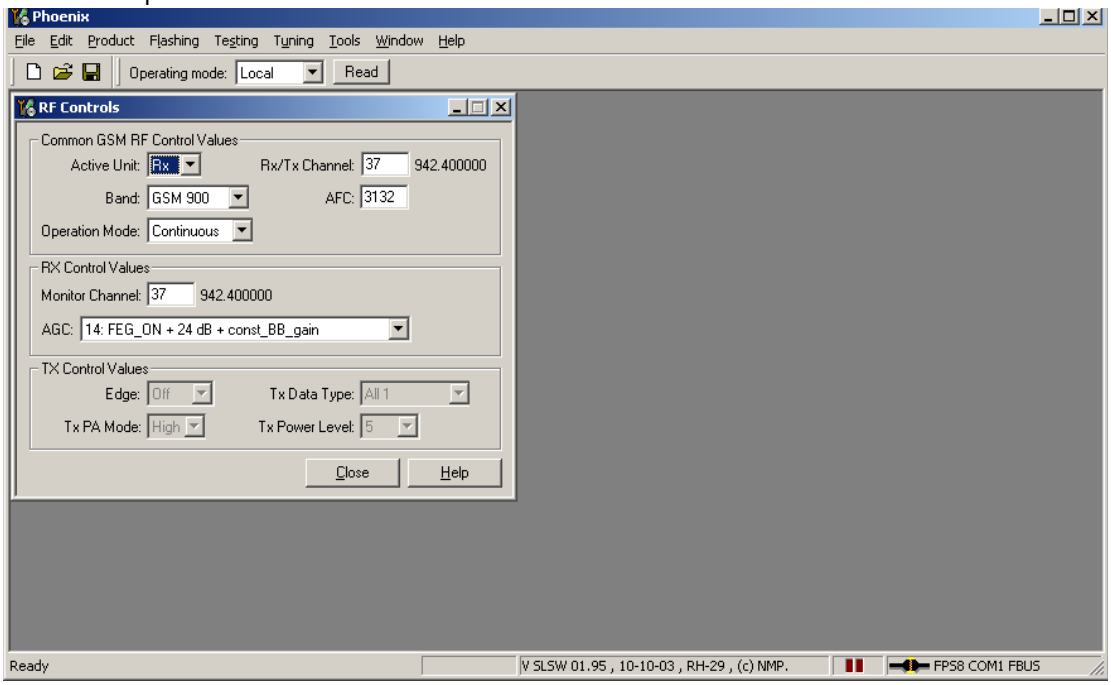
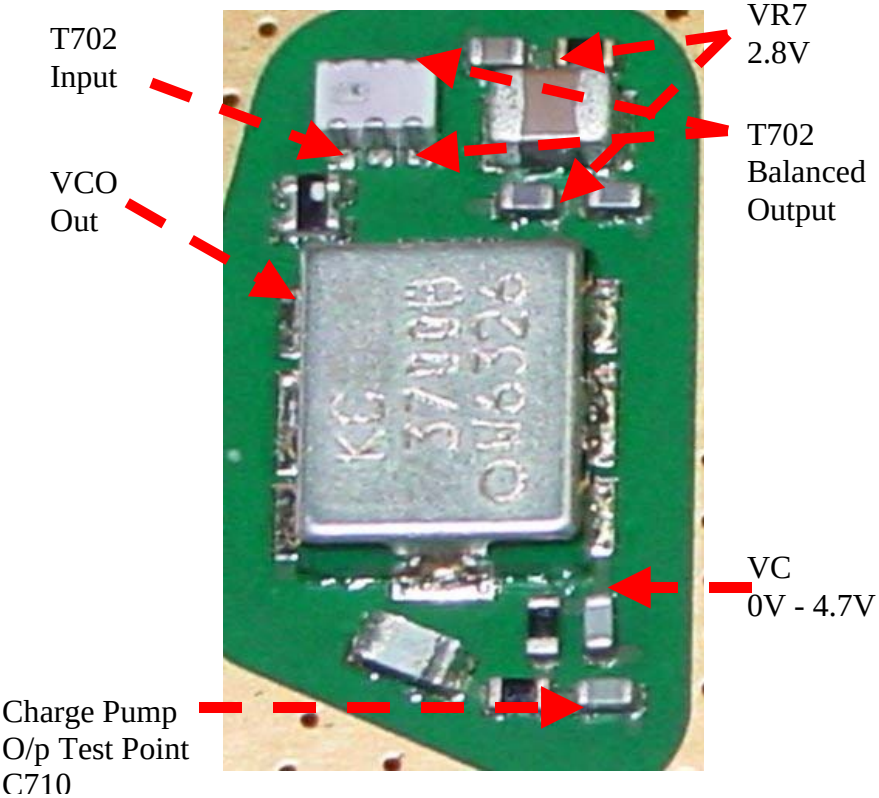
The setup should now look like this:



It is possible to measure frequency of 3769,6MHz at the output of the VCO (G701) using a resistive probe and a spectrum analyzer. It is possible to measure tuning voltage at charge pump output (C710) easily. For f_{VCO} = 3526.4MHz the tuning voltage should be 2.3V_{DC}. 2.8V_{DC} (Tuning sensitivity of VCO is 240MHz/V typ.).

Figure 14: PLL Synthesizer Test Points



If this is not the case, then go to troubleshooting chart in this document for trouble-

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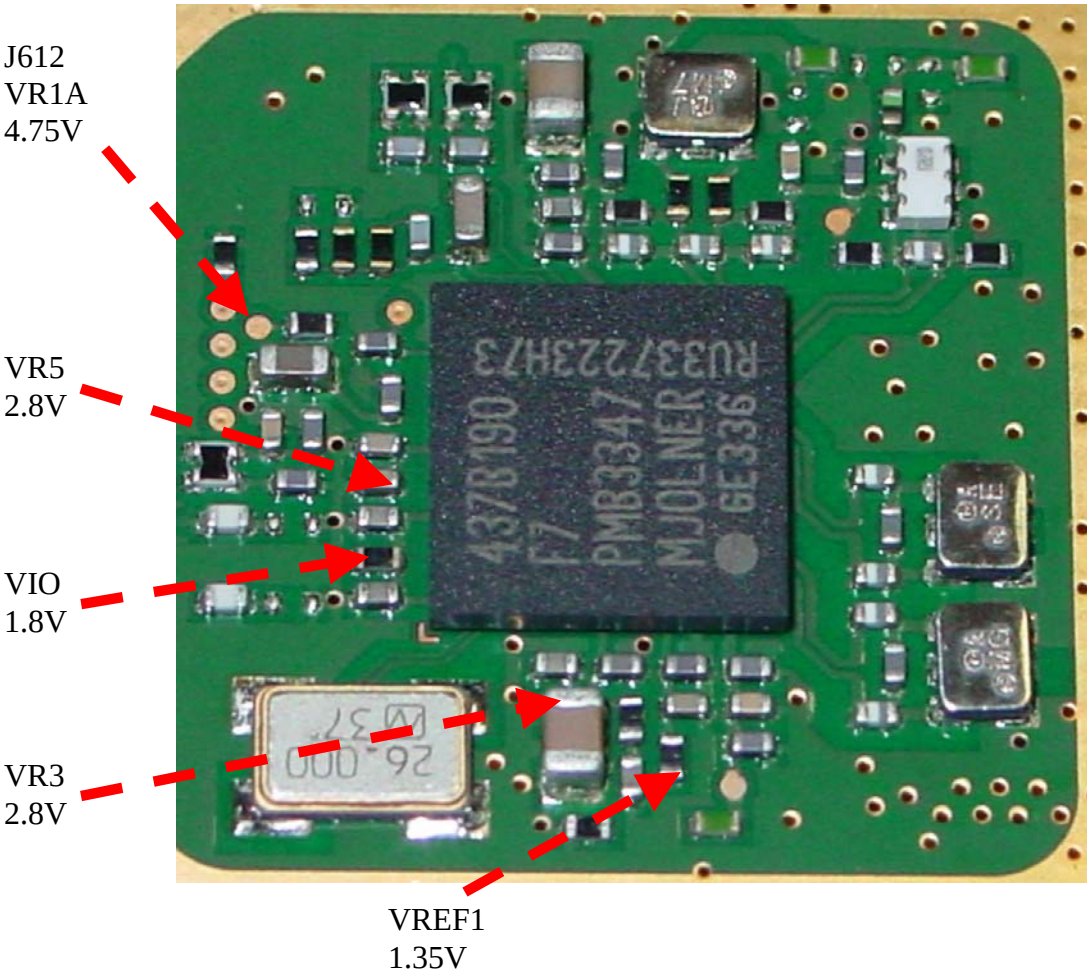
shooting.

Figure 15: Mjoelner Can Test Points



26 MHz reference oscillator (VCXO)

The 26 MHz reference oscillator (VCXO) is part of Mjoelner RF-ASIC (N601). It needs only an external 26 MHz Xtal (B601) as external circuitry.

The reference oscillator has three functions:

- Reference frequency for the PLL synthesizer.
- System clock for BB (RFClk_I = 26 MHz).
- 26 MHz Reference clock (LPRFClk_I) for Bluetooth Module (N430) via buffer V601.

For an error free initial synchronization, the 26MHz frequency of the VCXO must be accurate enough. Therefore, a **VCXO-calibration (cal)** value is written via the serial Bus into the RefOSCCAL register of Mjoelner and an additional bit in the RefOSCCntl register of the Mjoelner. That is necessary for the rough calibration of the VCXO.

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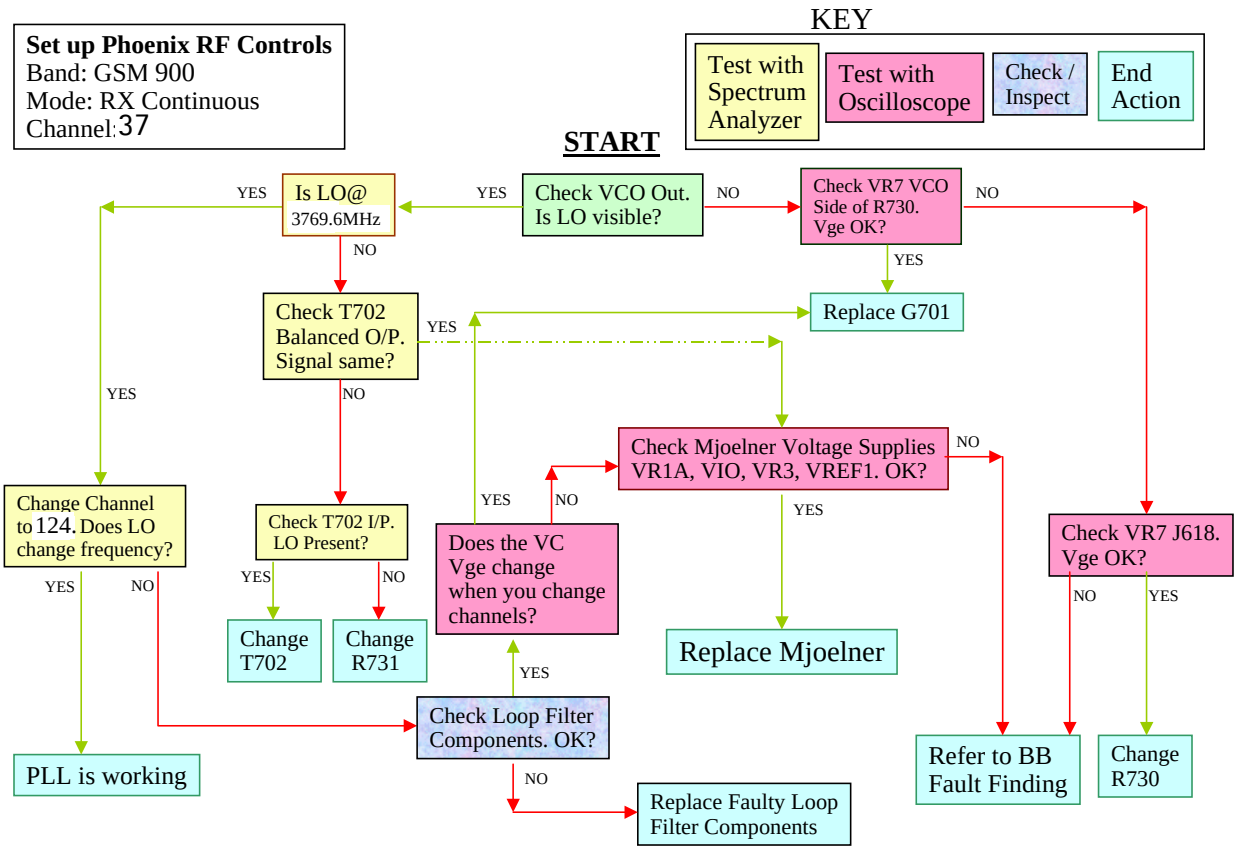
The VCXO is fine tuned by programming the AFC value via the serial bus of Mjoelner. The necessary AFC value is written into the RefOSCAFC register in Mjoelner.

VCO

The VCO is able to generate frequencies in the range from 3420MHz to 3840MHz when PLL is in function. The frequency of the VCO signal is divided by 2 or by 4 in Mjoelner RF-ASIC. So it is possible to generate the frequency of all channels in GSM900 and GSM1800 (both RX and TX). Frequency of the VCO is controlled by DC voltage (Vc) coming from the PLL loop filter. Range of Vc when PLL is in function is 0.7V– 3.8V. Typical tuning sensitivity of the VCO is 250MHz/V. Even if PLL is not working (Vc out of range) there is a frequency at the output of the VCO, which is between 3 and 4 GHz (if the VCO itself is ok).

troubleshooting chart for PLL Synthesizer



It is important to say that power supply for VCXO (VR3) is only switched 'OFF' in the so-called 'Deep Sleep Mode' and power supply for VCO (G701 VR7) is switched 'OFF' in so-called 'Sleep Mode'.

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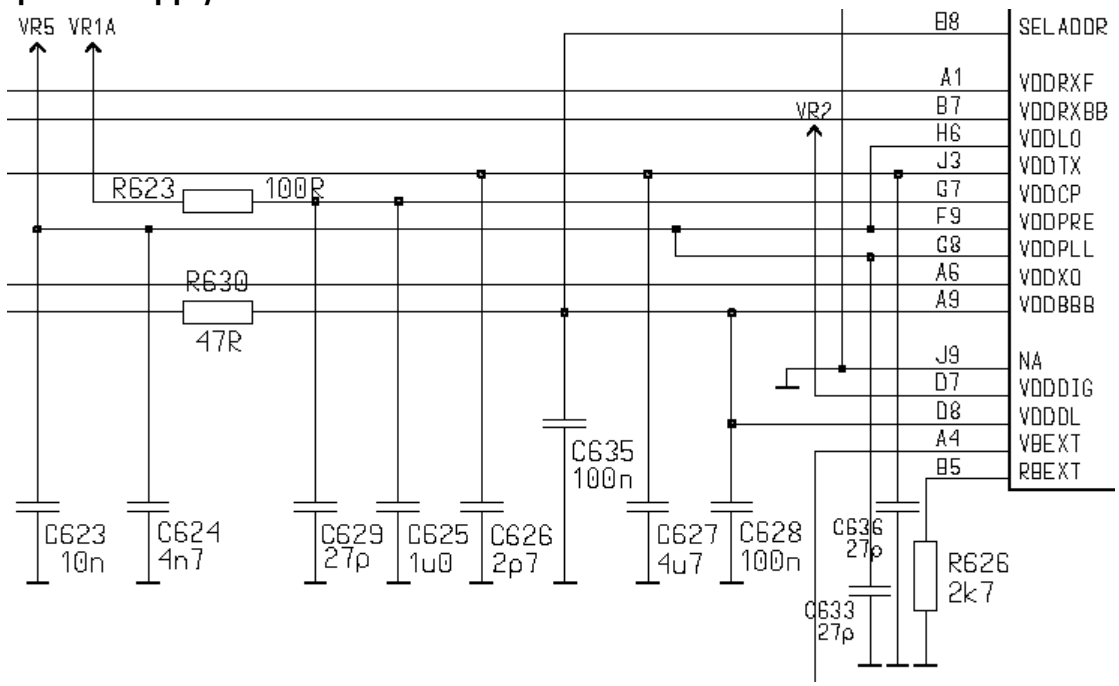
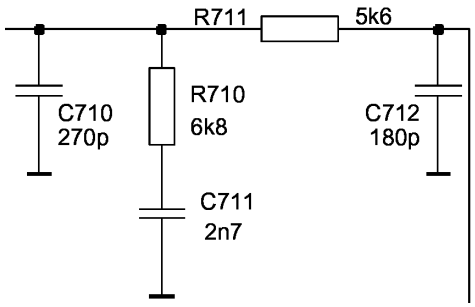
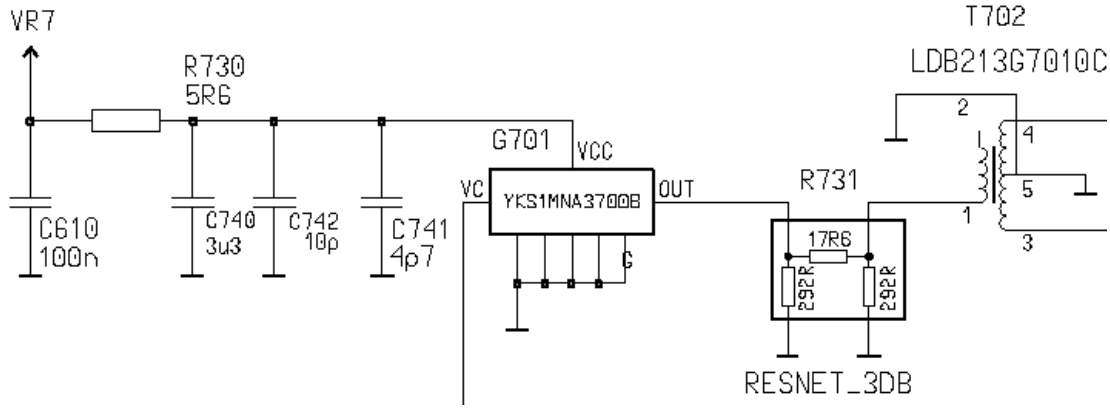
PLL power supply



Loop Filter



VCO and power supply



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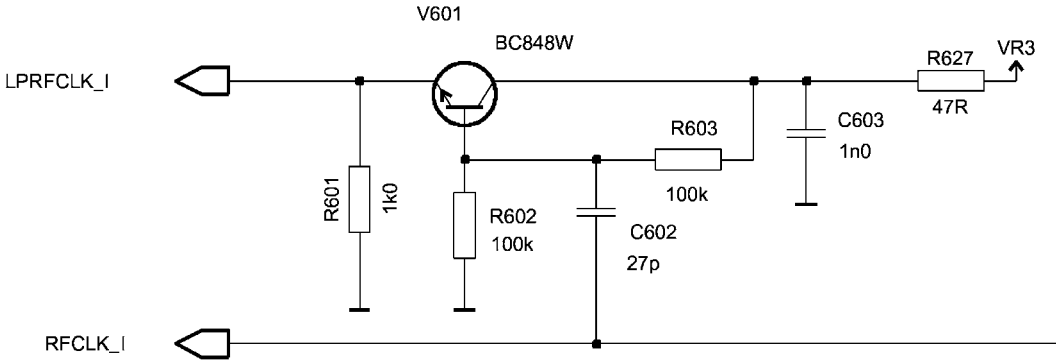
26MHz Bluetooth buffer



Antenna

Instructions for antenna troubleshooting

If the TX, RX or SX troubleshootings does not solve RF failure, do the following tests:

Use DA-17 jig and phone in 'local' mode. Use Phoenix to control the phone.

Set TX on and check the output power on low, middle and high channels. If the power levels are not OK, check the antenna, antenna connection pads and antenna pins. If there are big differencies (> 5 dB) between channels, change the antenna. If the levels are OK, the failure reason is bended center shield or in other part of the phone. Change the shield and try again. If it is still not functional, refer to BB troubleshooting.

Set RX on, connect signal generator to DA-17 and start RSSI testing. Check the RSSI levels on low, middle and high channels. If the RSSI levels are not OK, check the antenna, antenna connection pads and antenna pins. If there are big differencies (> 5 dB) between channels, change the antenna. If the RSSI levels are OK, the failure reason is bended center shield or in other part of the phone. Change the shield and try again. If it is still not functional, refer to BB troubleshooting.

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Phoenix Tuning

Connect the phone to a PC running the Phoenix Service Software.

Start Phoenix Service Software and open FBUS connection

Select File Scan Product

Wait until phone information is shown in the lower right corner of the screen.

RF tuning after repairs

Different repairs require different tuning. In general it is necessary to determine in which section the repair was done to select which tunings to perform. To determine if RF tuning is necessary after repair it is important that the functionality of the repaired circuit is understood well. It is recommended to perform complete RF tuning if RF is repaired.

- In general repairs in the TX part will require "TX Power Level Tuning" and "TX IQ Tuning".
- In general repairs in the RX part or PLL part always require "RX Calibration", “Rx Band Filter Response Calibration”.
- If Mjoelner is changed all calibrations have to be done.

Other parts interfacing to TX, RX or PLL might require tuning, but common sense should be used, e.g. if a component that has no influence on RF performance has been changed, e.g. the microphone, on/off key, mechanical parts or similar, there is no need to do any RF tuning.

RX channel select filter calibration

This calibration is calibrating the Base band filter inside Mjoelner. It is done by internally measuring a prototype filter, for this reason the calibration is done once, not separately in 2 bands.

Set operating mode to local mode

Select Tuning Alt-U

RX Channel Select filter Calibration F

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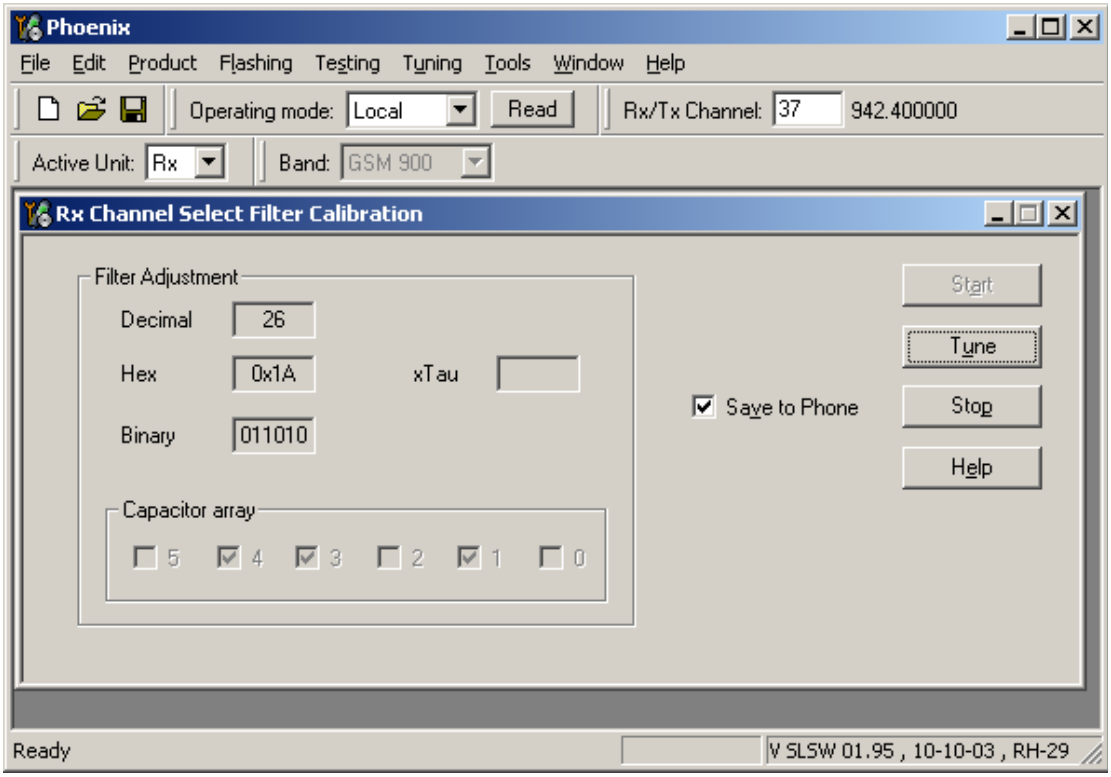
The setup should now look like this:



Press Tune and the optimal values are found.

Make sure that Save to Phone is active. It can be activated by clicking with mouse or by pressing the letter v.

Press Stop and the RX Channel Select Filter Calibration is finished. You can now leave the tuning by closing the window.

RX calibration (incl. VCXO Calibration)

The "RX calibration" is used to determine gain at different gain-settings for front-end and Mjoelner and needs to be done in both bands.

RX-calibration requires an external signal generator.

RX-calibration in EGSM900 combines two tunings, VCXO-calibration and AGC-calibration:

Calibration of GSM1800 band only determines AGC values.

The **VCXO-calibration** finds out a calibration value for VCXO control, an AFC initial value and 3 AFC-slope coefficients.

A value (RF_TEMP), which represents the RF hardware temperature, is determined during RX Calibration. This temperature value is used by DSP to RSSI reporting in Normal mode

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of the phone. It is not visible in the calibration process.

AGC-calibration:

The AGC-calibration finds the gain values of the RX-gain system.
The AGC consists of RF LNA, which can be either on or off (gain difference between on and off state is nominally 30dB) and BB gain which can be controlled in 6dB steps. This gives 15 gain steps RSSI0 to RSSI14. LNA is off for steps RSSI0 to RSSI4.
AGC-calibration measures the gain at gain step RSSI4 and RSSI7. The other gain values are calculated.

VCXO-calibration:

The VCXO-calibration ensures the function of an **initial** synchronization (before location update is done) when the mobile station is in Normal mode. For an error free initial synchronization, the 26MHz frequency of the VCXO must be accurate enough. Therefore, a **VCXO cal** value is written into the RefOSCCAL register of the Mjoelner.

During VCXO-calibration, the **VCXO cal** value is changed by a DSP-algorithm until a synchronization is possible. This means the VCXO oscillates at 26 MHz with a sufficient minimum frequency error.

To further minimize the frequency error, an initial **AFC value** is determined by the DSP and written into RefOSCAFC register of the Mjoelner.

Also the DSP algorithm determines 3 AFC slope coefficients **Slope C1...3** during VCXO calibration. One AFC slope value is not sufficient for Mjoelner **F3**, because the AFC slope is non-linear in this chip.

EGSM900 and DCS1800

Select	Tuning		Alt-U
		RX Calibration	C

Wait until the RX Calibration window pops up.

Select	Band	GSM900

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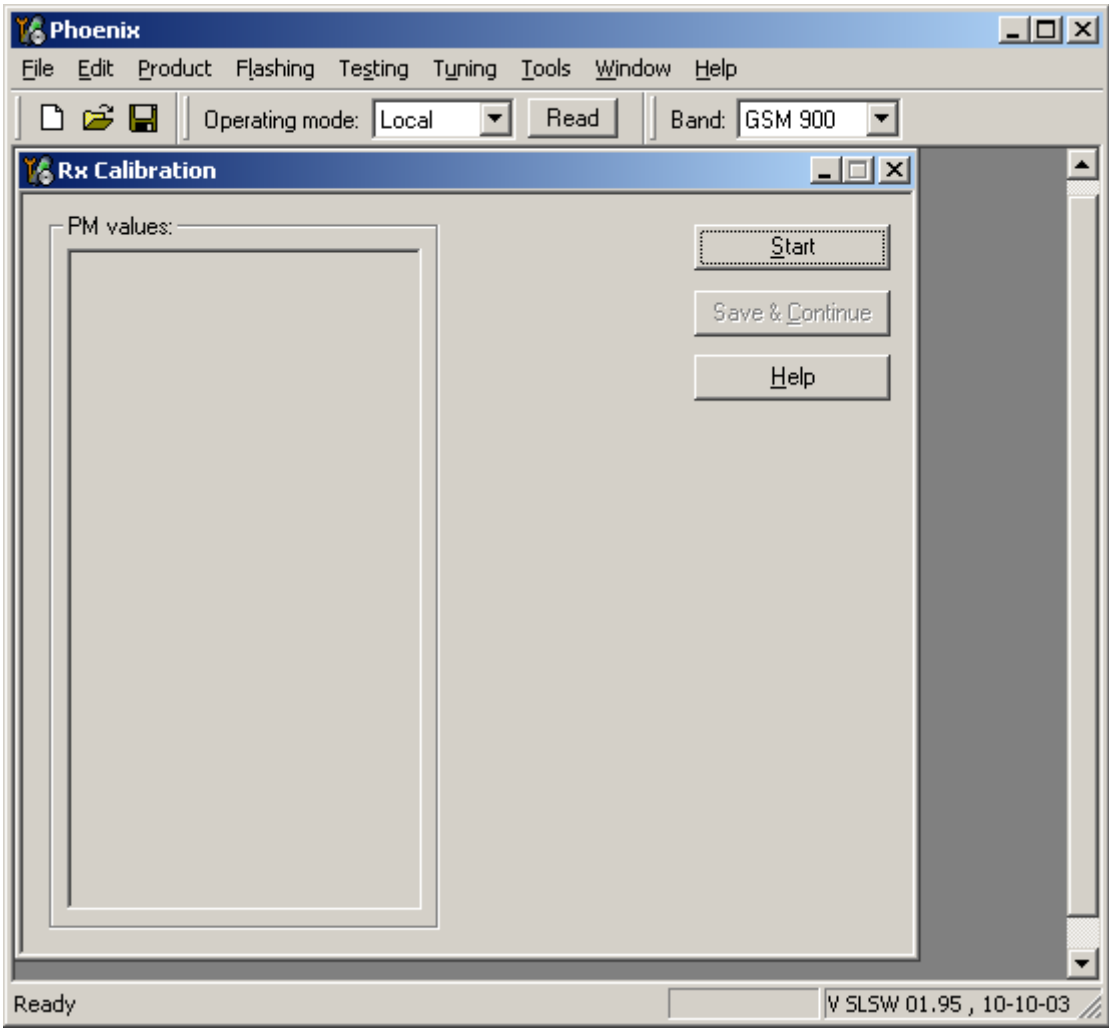
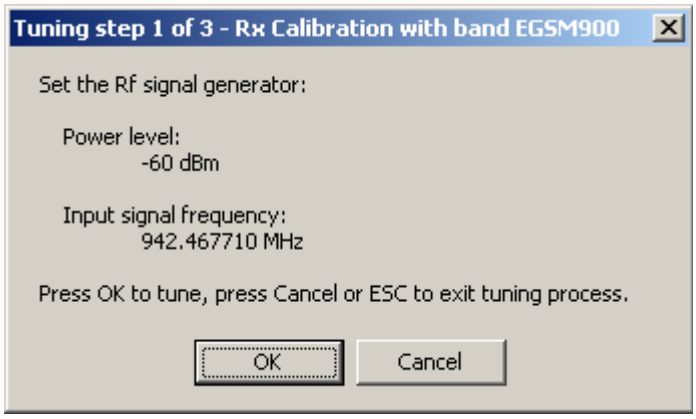
The setup should now look like this:



Press Start and a new window pops up:


Tuning step 1 of 3 - Rx Calibration with band EGSM900
Set the Rf signal generator:
Power level:
-60 dBm
Input signal frequency:
942.467710 MHz
Press OK to tune, press Cancel or ESC to exit tuning process.
OK
Cancel

Connect an external signal generator to the RF connector of the phone and set the generator as told in the window, taking care for external cable losses.

Press OK and the window closes.

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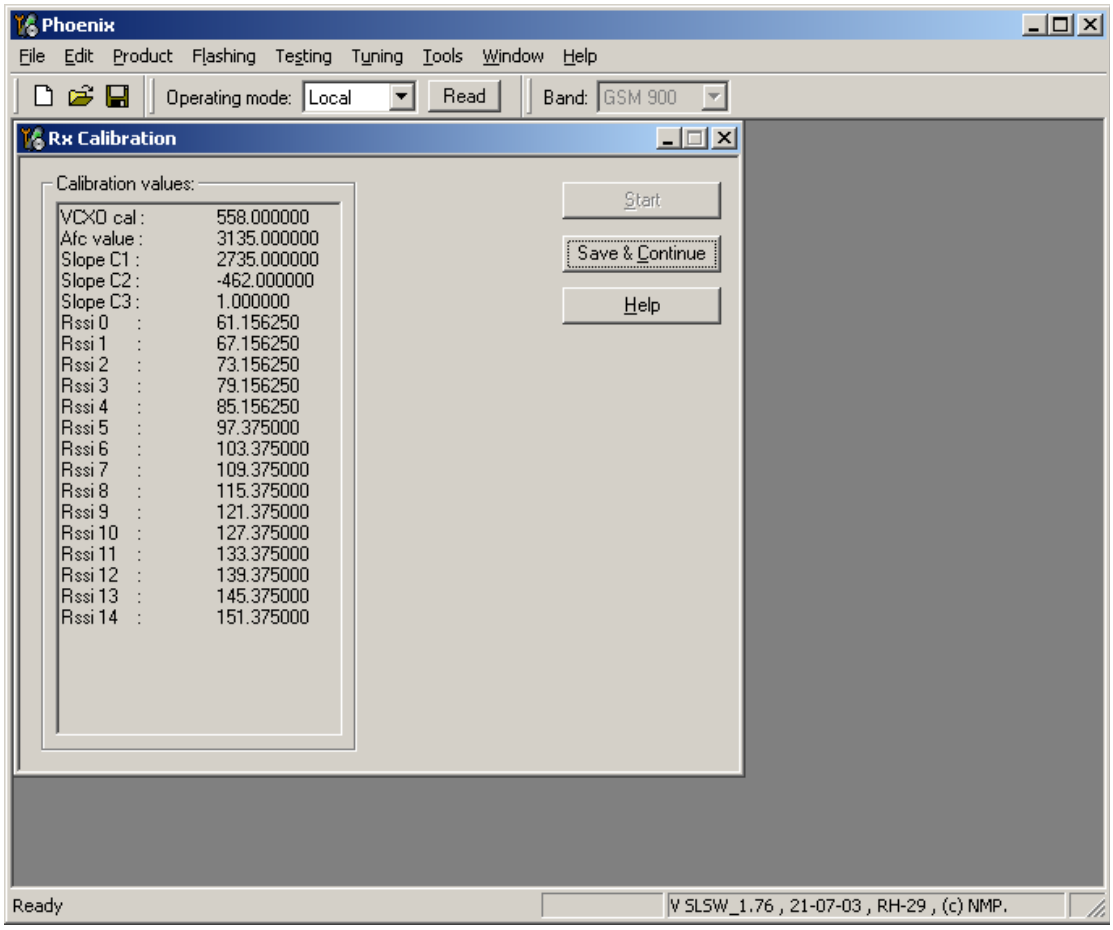
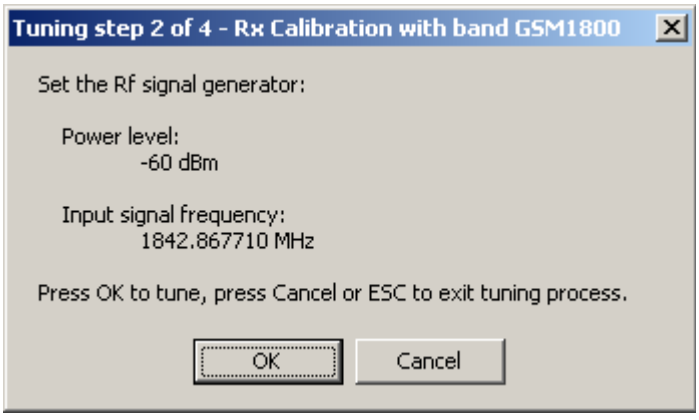
A typical result will look like this:



The EGSM900 has been tuned. To proceed to DCS1800 tuning, press Save & Continue and a new window pops up::


Tuning step 2 of 4 - Rx Calibration with band GSM1800
Set the Rf signal generator:
Power level:
-60 dBm
Input signal frequency:
1842.867710 MHz
Press OK to tune, press Cancel or ESC to exit tuning process.
OK
Cancel

Let an external signal generator be connected to the RF connector of the phone and set the generator as told in the window, taking care of external cable losses.

Press OK and the window closes.

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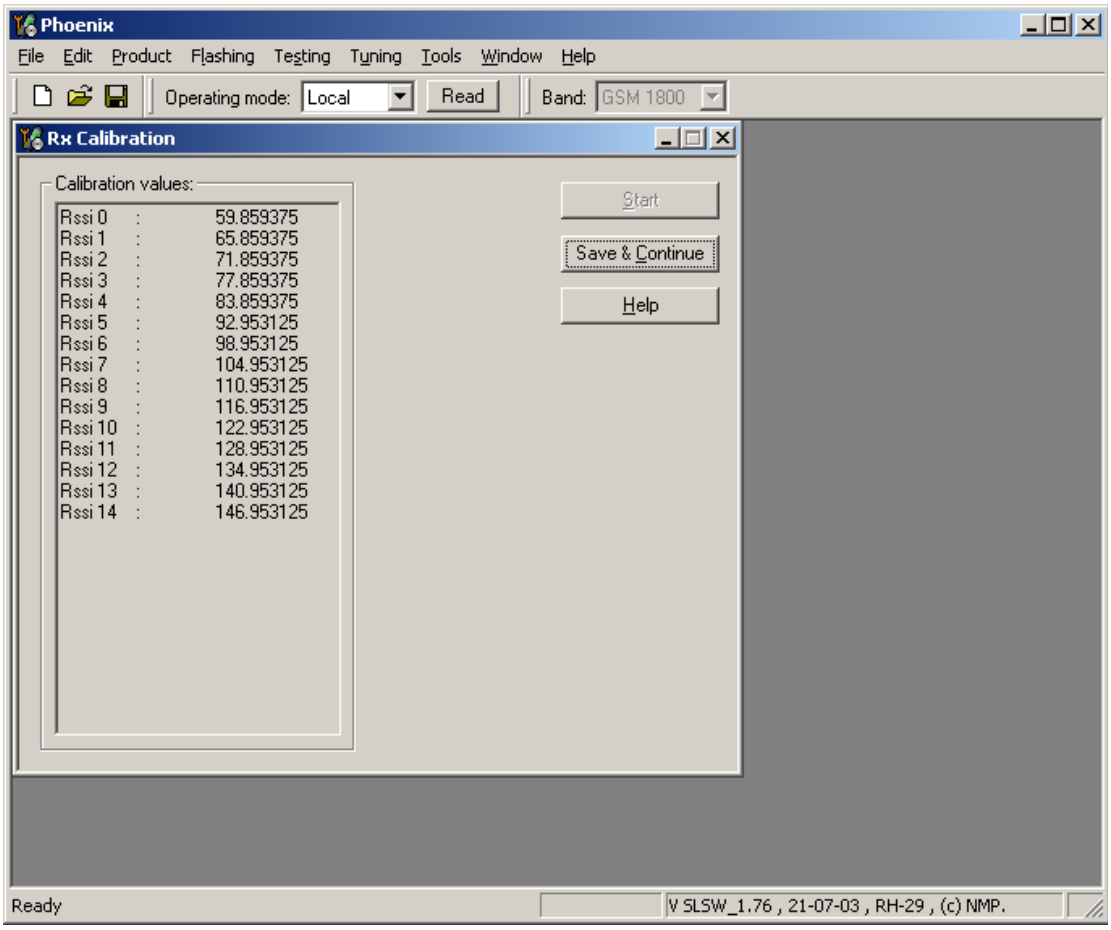
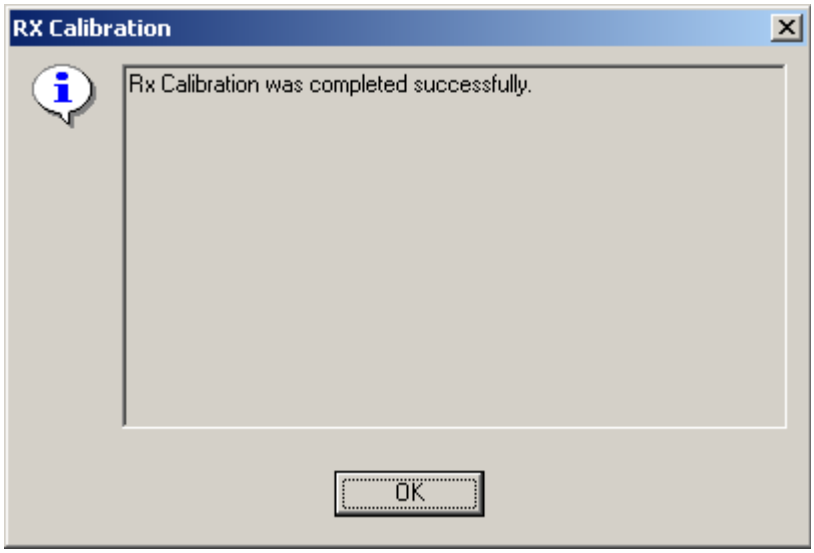
A typical result will look like this:



Press Save and Continue, and a new window pops up:



Press OK and the RX Calibration of the EGSM900 and DCS1800 are finished.

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RX AGC limits

The Rx calibration is only valid if it is within certain limits.

For the most recent limits see RH-29 Production Testing Requirements,

If calibration is not within limits, there is a fault in the RX chain.

Below the values for RSSI4 and RSSI7 are given:

RSSI4:

Table 2:

band	min	typ	max
EGSM900	81	86	91
DCS1800	79	85	89

RSSI7:

Table 3:

band	min	typ	max
EGSM900	103	108	113
DCS1800	100	104	110

RX band filter response compensation

EGSM900 and DCS1800

Set operating mode to local mode

Select Tuning Alt-u

RX Band Filter Response Compensation B

Select Band EGSM900

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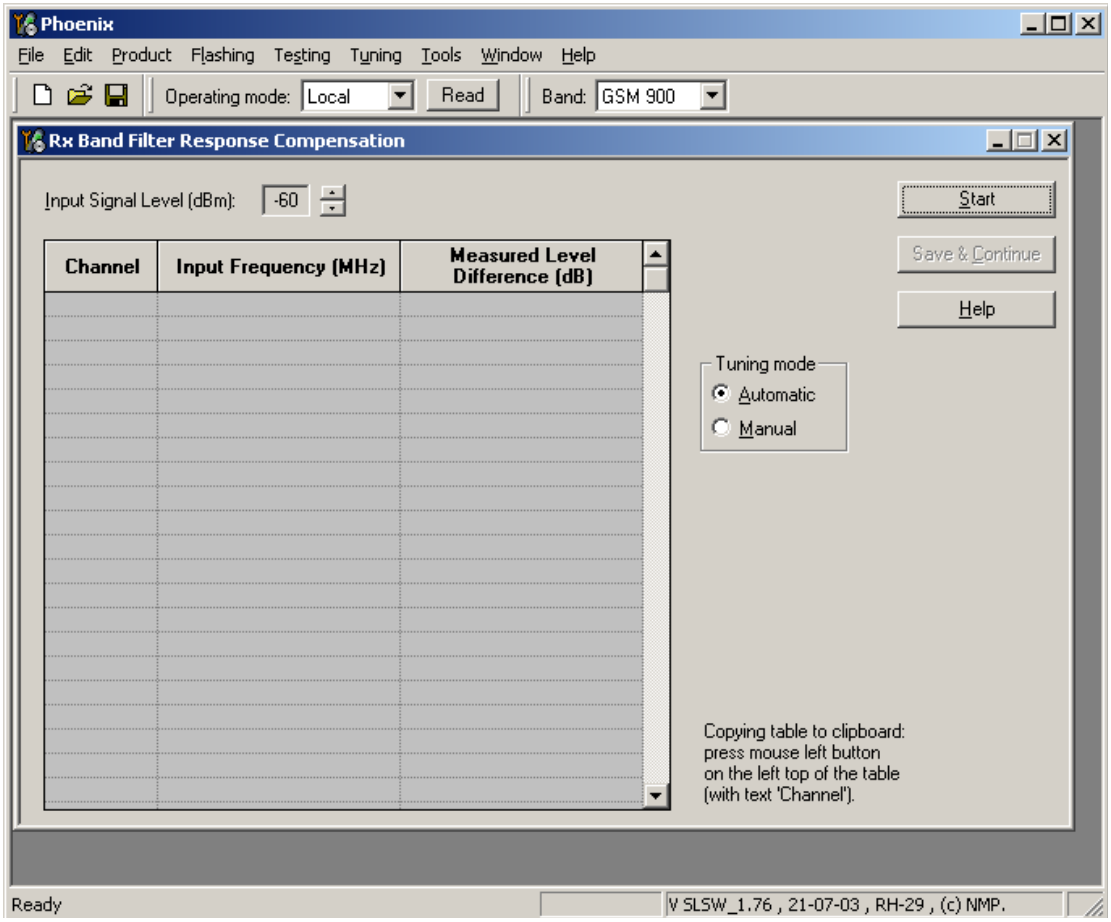
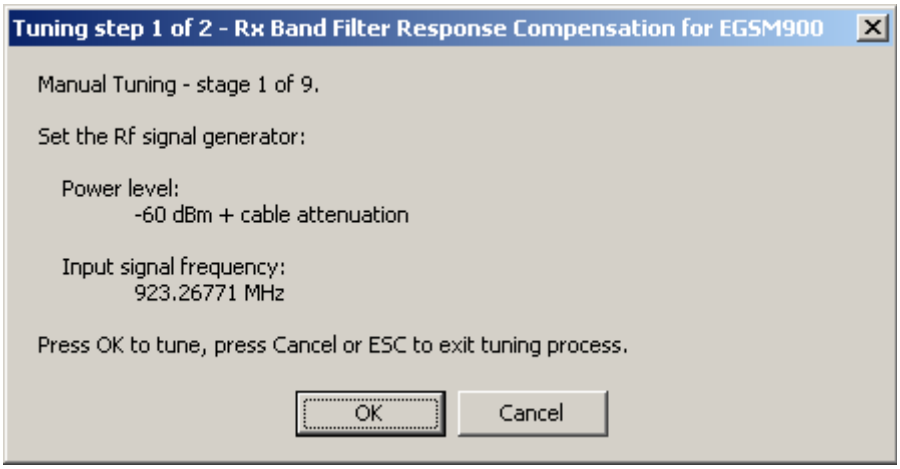
The setup should now look like this:



Select Input Signal Level -60dBm

Manual tuning

Press Manual tuning and a window pops up:


Tuning step 1 of 2 - Rx Band Filter Response Compensation for EGSM900
Manual Tuning - stage 1 of 9.
Set the Rf signal generator:
Power level:
-60 dBm + cable attenuation
Input signal frequency:
923.26771 MHz
Press OK to tune, press Cancel or ESC to exit tuning process.
OK
Cancel

Connect an external signal generator to the RF connector of the phone and set the generator as told in the window.

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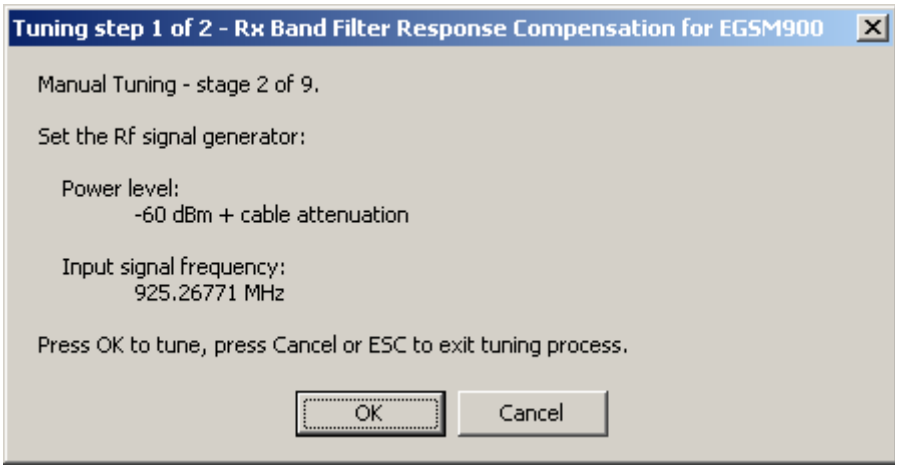
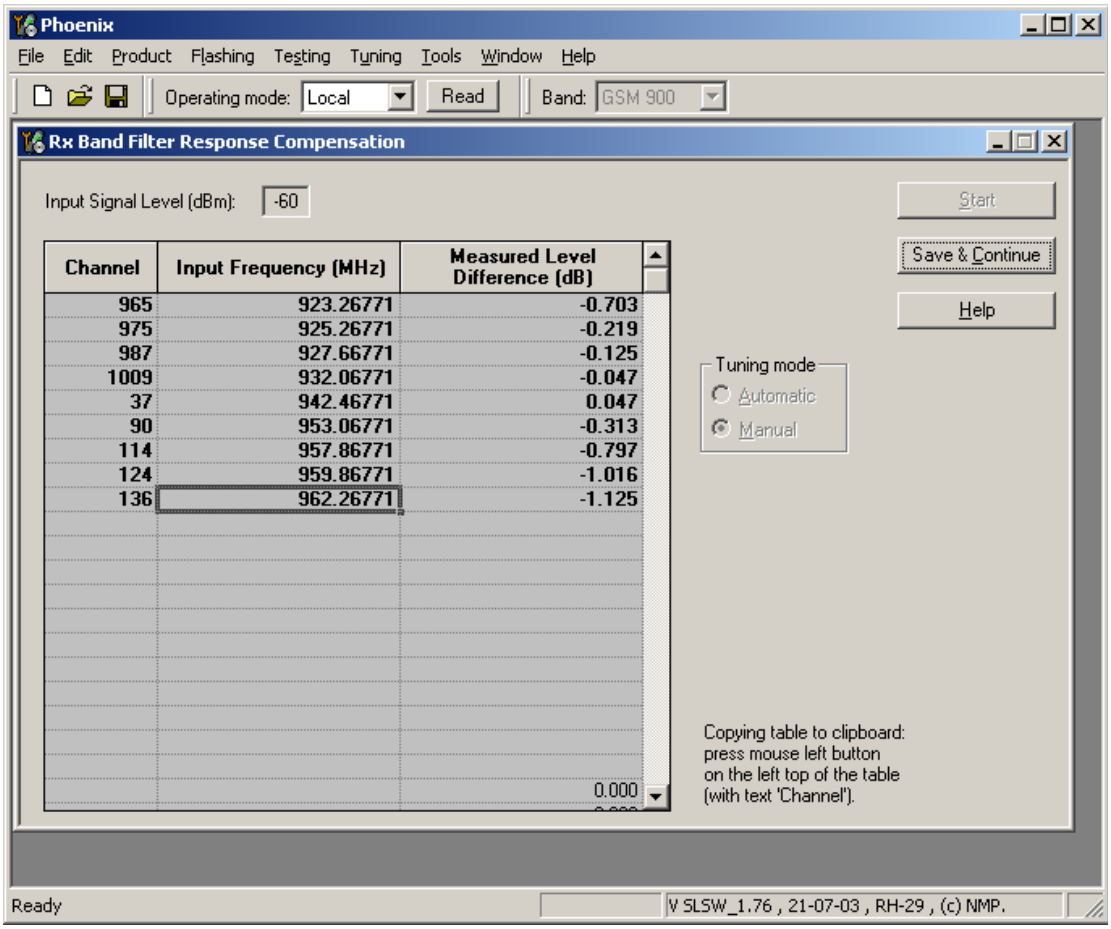
Press OK and a new window pops up:


Tuning step 1 of 2 - Rx Band Filter Response Compensation for EGSM900
Manual Tuning - stage 2 of 9.
Set the Rf signal generator:
Power level:
-60 dBm + cable attenuation
Input signal frequency:
925.26771 MHz
Press OK to tune, press Cancel or ESC to exit tuning process.
OK
Cancel

Set the generator as told in the window.

Press OK and a new window pops up. Repeat this sequence **9 times** until all channels are done.

A typical result will look like this:



The EGSM900 has been tuned. Press Save and Continue to proceed to DCS1800 tuning.

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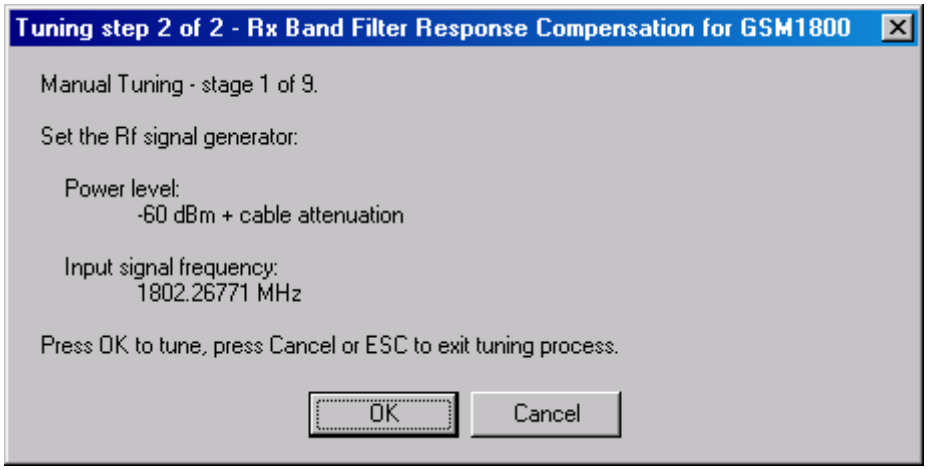
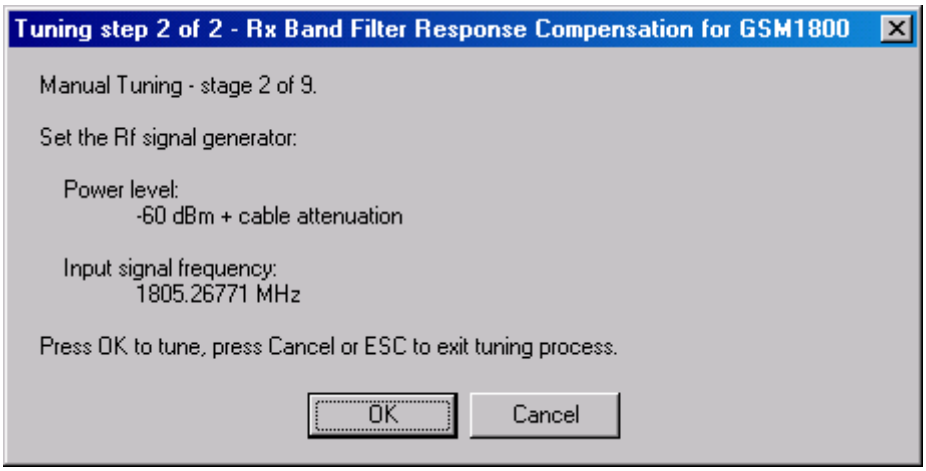
A window pops up:


Tuning step 2 of 2 - Rx Band Filter Response Compensation for GSM1800
Manual Tuning - stage 1 of 9.
Set the Rf signal generator:
Power level:
-60 dBm + cable attenuation
Input signal frequency:
1802.26771 MHz
Press OK to tune, press Cancel or ESC to exit tuning process.
OK
Cancel

Let the external signal generator be connected to the RF connector and set the generator as told in the window, taking care of external cable losses. Press OK and the following window pops up:


Tuning step 2 of 2 - Rx Band Filter Response Compensation for GSM1800
Manual Tuning - stage 2 of 9.
Set the Rf signal generator:
Power level:
-60 dBm + cable attenuation
Input signal frequency:
1805.26771 MHz
Press OK to tune, press Cancel or ESC to exit tuning process.
OK
Cancel

Set the generator as told in the window.

Press OK and a new window pops up. Repeat this sequence **9 times** until all channels are done.

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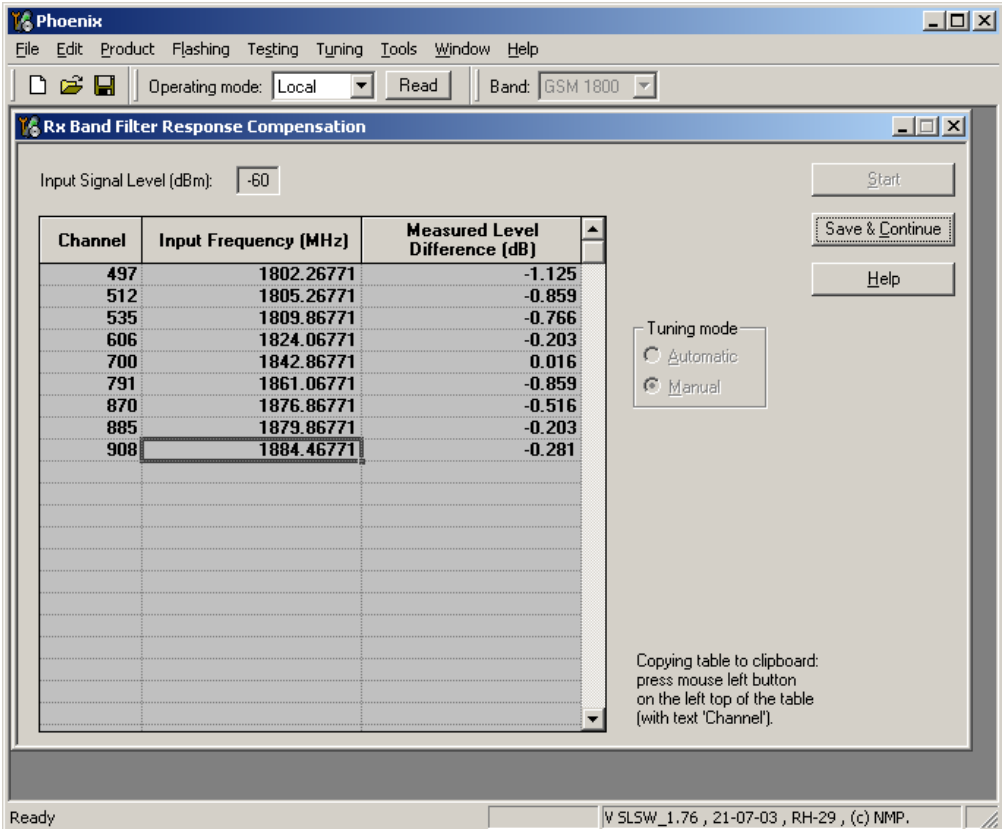
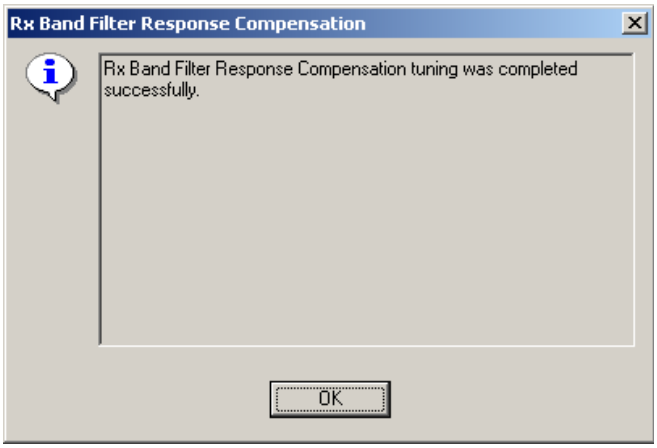
A typical result will look like this:



Select Input Signal Level -60dBm

The DCS1800 has been tuned. Press Save and Continue to finish the tuning. A new window pops up:



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TX I/Q tuning

This tuning must be done in both bands.

EGSM900

Caution: In case you use a spectrum analyser make sure that the external attenuation (20 - 30dB) between phone and spectrum analyser is high enough that the input of the analyser can't be destroyed. Adjust the reference level offset according to the insertion loss from the phone to the spectrum analyser.

PC/Phone operation:

Set operating mode to local mode

Select Tuning Alt-u

TX IQ Tuning I

Wait until the TX IQ Tuning window pops up.

Select Testing Alt-s

RF Controls R

Wait until the RF Controls window pops up.

Connect a Spectrum Analyzer or GSM tester with the option *Narrow Spectrum' to the RF connector of the phone.

If a spectrum analyzer is used then use the following settings.

Table 4:

	EGSM900
Center Frequency	897.4 MHz
Frequency Span	200 kHz
Resolution Bandwidth	3kHz
Video Bandwidth	3kHz
Sweep Time	3 sec.
Sweep Type	Clear/Write
Detector Type	Max Peak
Reference level	35 dBm
Marker 1	897.33229 MHz
Marker 2	897.4 MHz
Marker 3	897.46771 MHz

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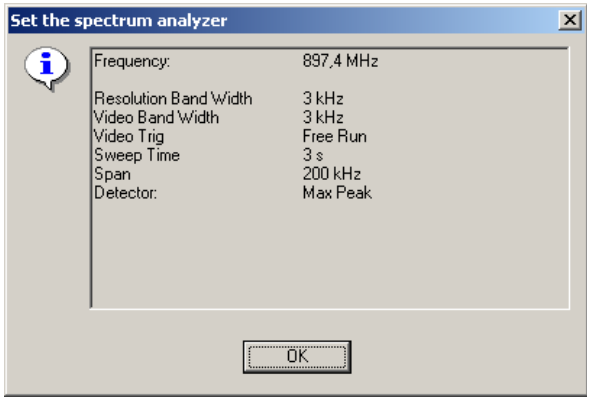
Select in the RF Controls Window:

Select	Band	GSM900
	Active Unit	TX
	Operation Mode	Burst
	RX/TX Channel	37
	TX PA Mode	Free
	TX Data Type	All1

Press Start

The following window pops up:



Select again in the RF Controls Window:

Select	TX Power Level	5

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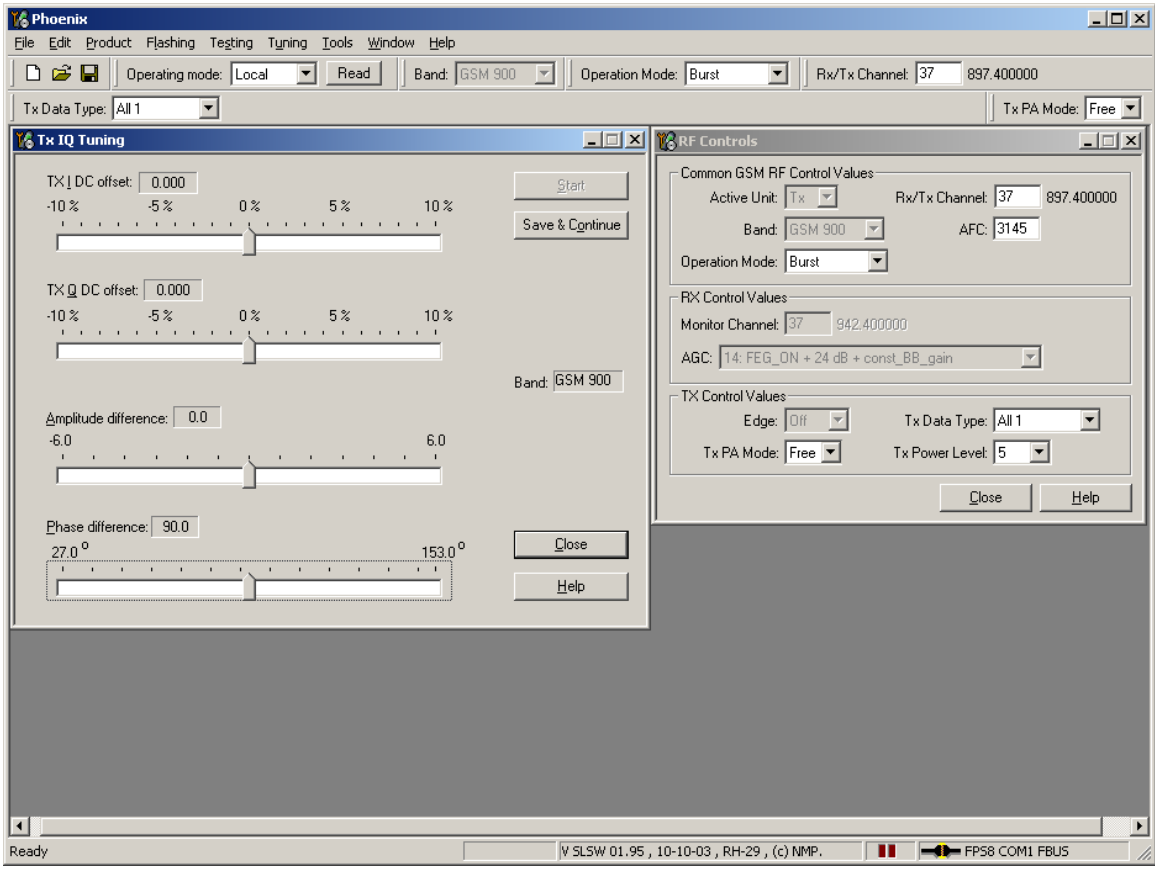
The setup should now look like this:



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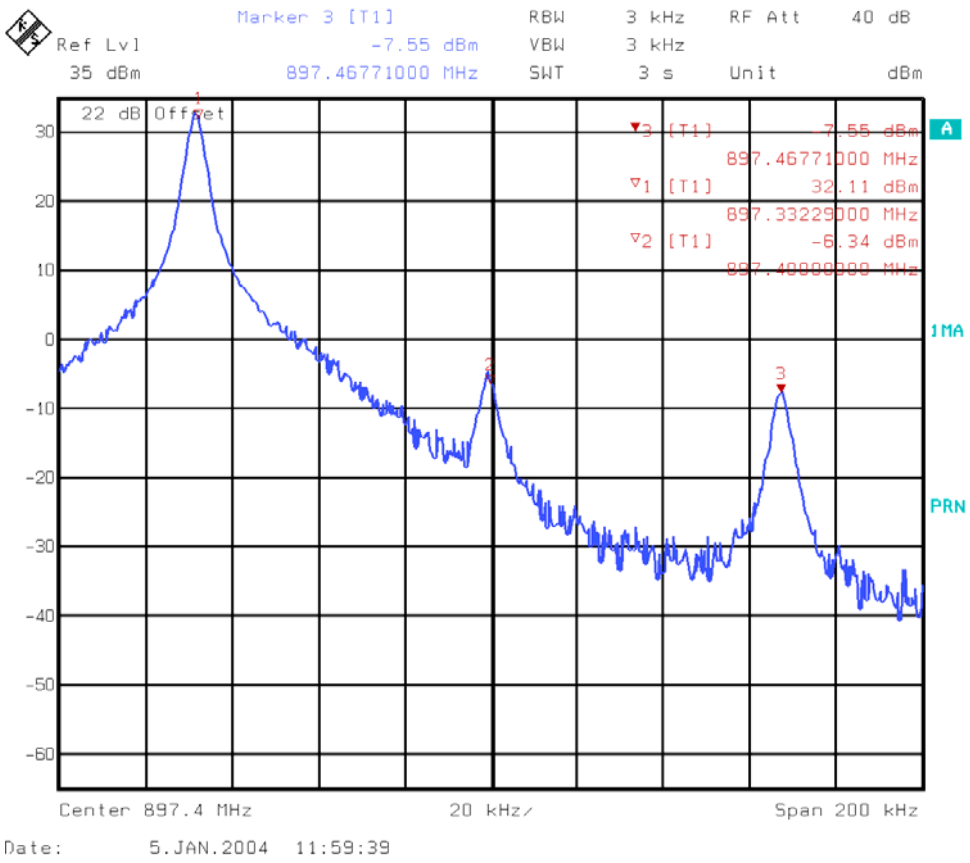
The Spectrum Analyzer now shows a plot like this:



The purpose of this tuning is to tune the carrier signal and the +67kHz signal to a minimum level (Marker 2 and 3).

Use the variables 'TX I DC offset' and 'TX Q DC offset' to adjust the carrier signal to a minimum level (Marker 2).

After tuning to the minimum the level difference between the peak levels at marker 1 and 2 must exceed 40dB.

Tuning is possible by using arrow keys on the keyboard. Pushing the sliders by using the mouse is less sensitive but even possible.

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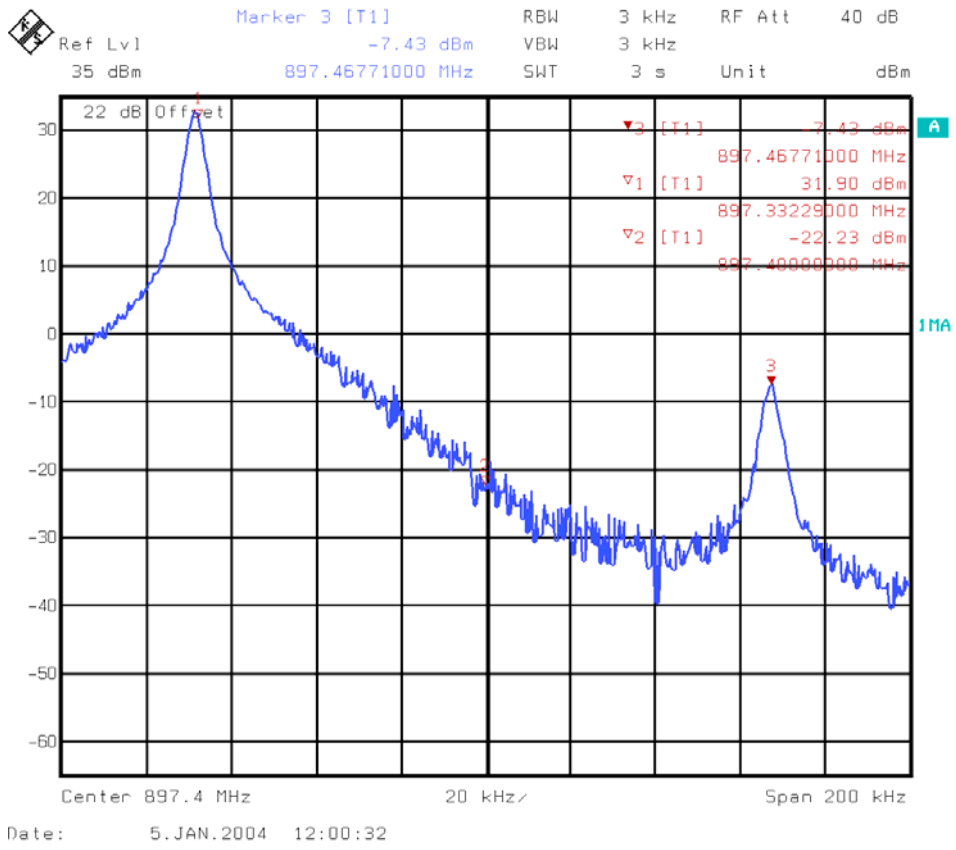
The Spectrum Analyzer now shows a plot like this:



Use the variables 'Amplitude difference' and 'Phase difference' to adjust the +67kHz signal to a minimum level (Marker 3). After tuning to the minimum the level difference between the peak levels at marker 1 and 3 must exceed 40dB. Tuning is possible by using arrow keys on the keyboard. Pushing the sliders by using the mouse is less sensitive but even possible.

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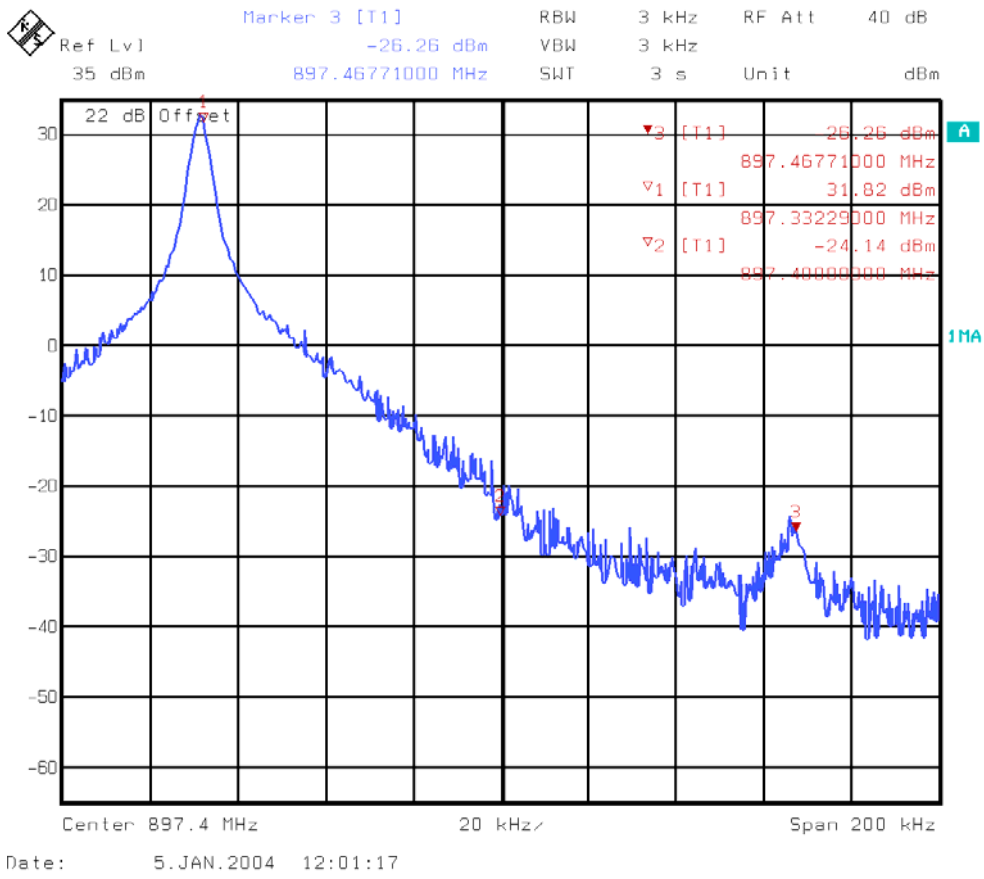
The Spectrum Analyzer now shows a plot like this:



Select again in the RF Controls Window:

Select "Save and Continue"

Press Stop and the values are stored in the phone.

The EGSM TX IQ Tuning is now finished and tuning continues in the DCS1800 band.

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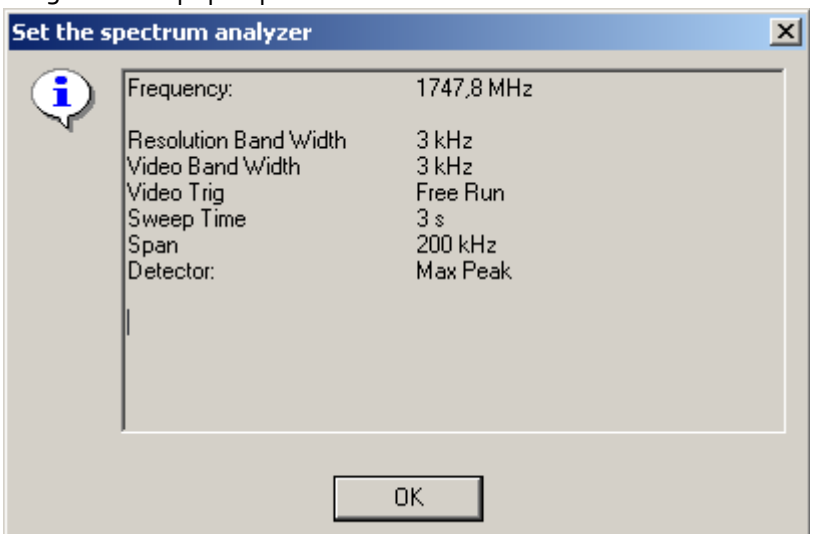
DCS1800

If a spectrum analyzer is used then use the following settings.

Table 5:

	DCS1800
Center Frequency	1880 MHz
Frequency Span	200 kHz
Resolution Bandwidth	3 kHz
Video Bandwidth	3 kHz
Sweep Time	3 sec.
Sweep Type	Clear/Write
Detector Type	Max Peak
Reference level	35 dBm
Marker 1	1747.73229 MHz
Marker 2	1747.8 MHz
Marker 3	1747.86771 MHz

The following window pops up:



Select in the RF Controls Window:

Select TX Power Level 0

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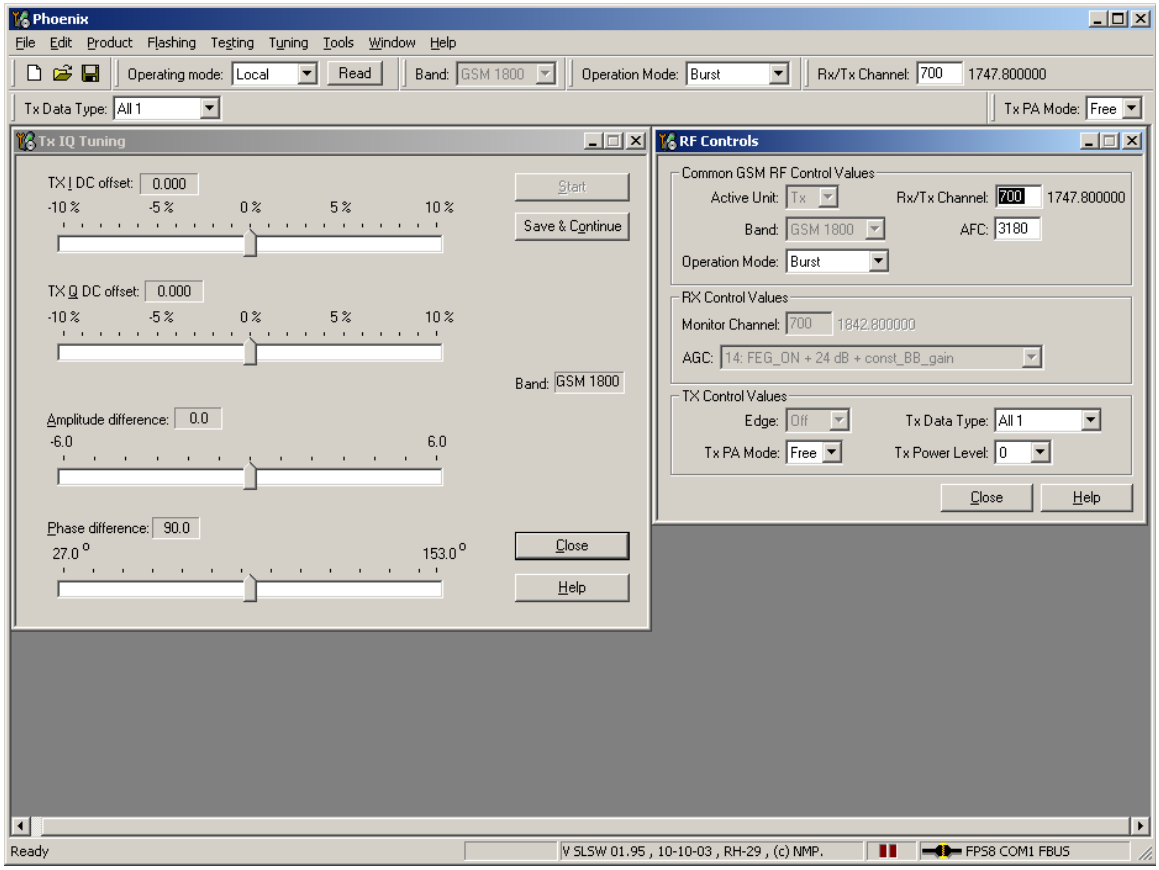
The setup should now look like this:



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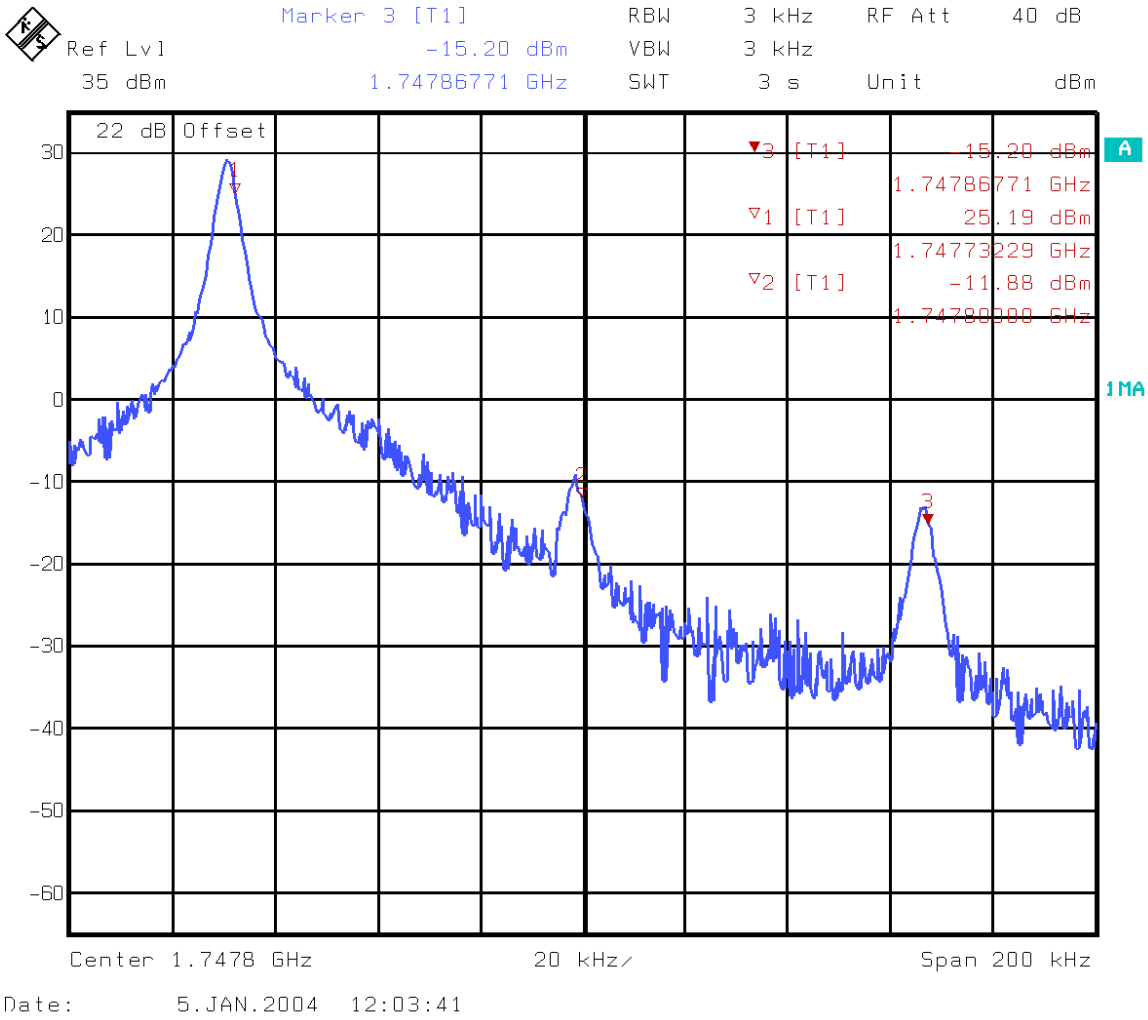
The Spectrum Analyzer now shows a plot like this:



The purpose of this tuning is to tune the carrier signal and the +67kHz signal to a minimum level (Marker 2 and 3).

Use the variables 'TX I DC offset' and 'TX Q DC offset' to adjust the carrier signal to a minimum level (Marker 2).

After tuning to the minimum the level difference between the peak levels at marker 1 and 2 must exceed 40dB.

Tuning is possible by using arrow keys on the keyboard. Pushing the sliders by using the mouse is less sensitive but even possible.

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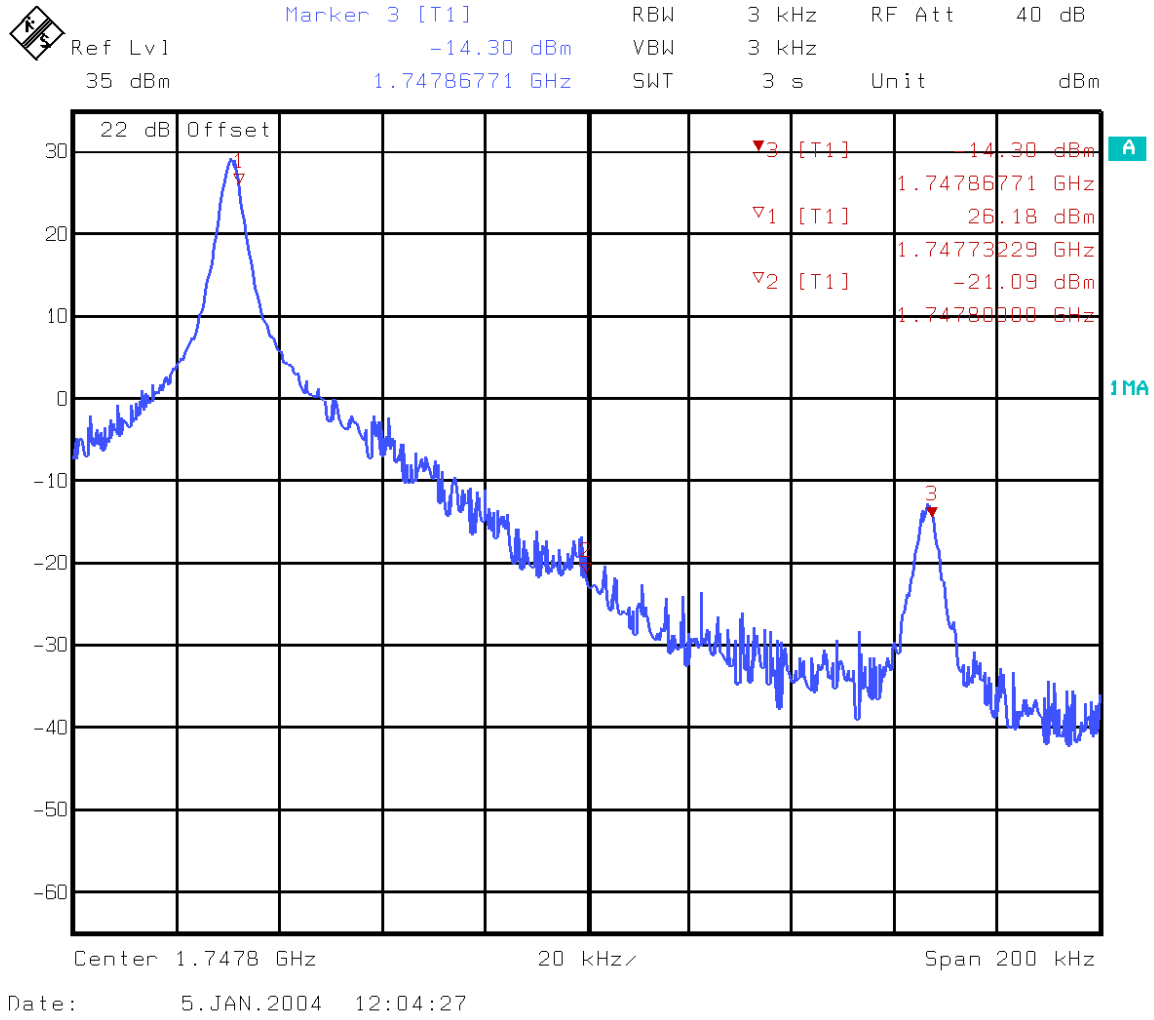
The Spectrum Analyzer now shows a plot like this:



Use the variables 'Amplitude difference' and Phase difference' to adjust the +67KHz signal to a minimum level (Marker 3). After tuning to the minimum the level difference between the peak levels at marker 1 and 3 must exceed 40dB, Tuning is possible by using arrow keys on the keyboard. Pushing the sliders by using the mouse is less sensitive but even possible'

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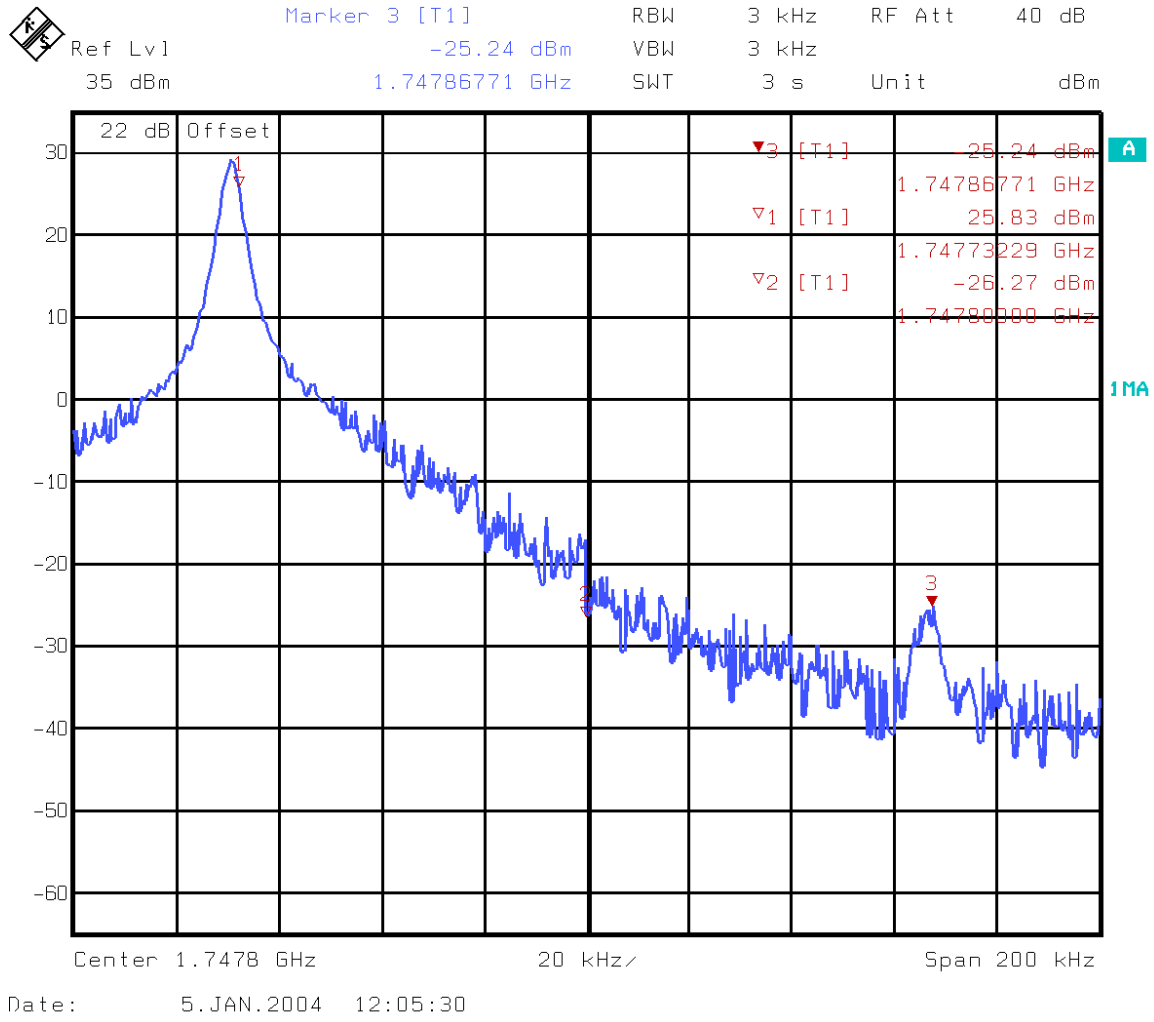
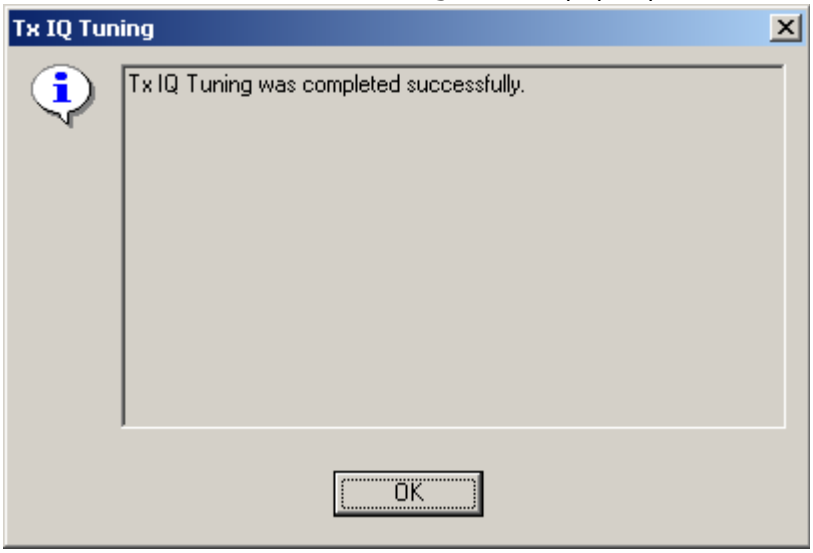
The Spectrum Analyzer now shows a plot like this:



Press "Save and Continue" and the following window pops up:



Now the TX IQ tuning has been finished.

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Note: the optimal values for "TX I and Q Offset" and "Amplitude and Phase Difference" vary from phone to phone.

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TX power tuning

This tuning must be done in both bands.

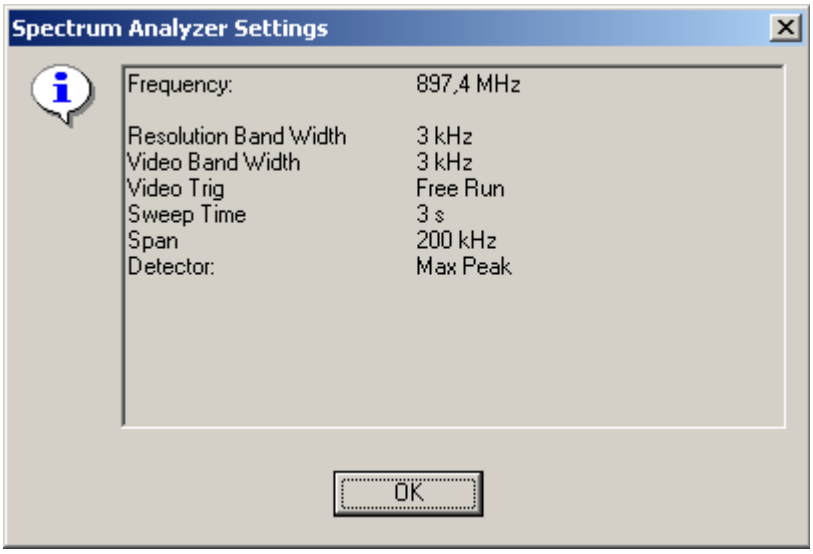
Note: TX Power tuning must be done with a peak power meter, e.g. Anritsu model ML2408A with Anritsu Peak Power Sensor MA2442A and a suitable attenuator. Tuning can also be done with a spectrum analyzer.

The use of power meter in GSM testers is likely to cause larger error than the use of a dedicated power meter and might cause the phone to be non-compliant with GSM specifications.

Connect a **calibrated** power meter to the RF connector of the phone.

Select	Testing	Alt-S	
	RF controls	R	
Select	Tuning		Alt-u
	TX Power Level Tuning		L
Select	Band	GSM900	
	Active Unit		TX

Press Start and the following window pops up:



If you are using a spectrum analyser, make the necessary settings. Press OK to continue.

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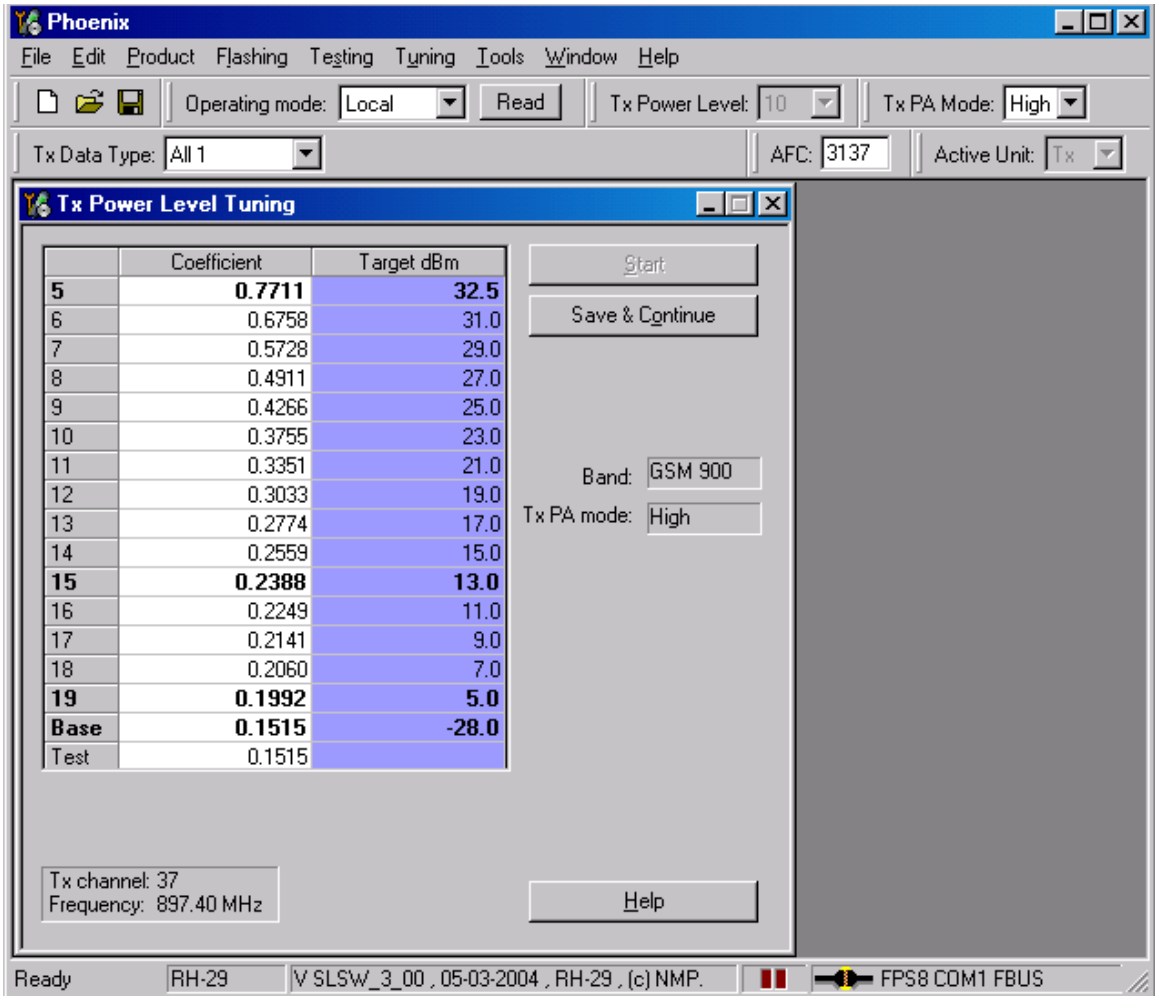
The setup should now look like this:



If you are using a spectrum analyzer, adjust the marker to the highest peak to see the power level.

Tune Base level to –30 dBm.

Adjust DAC Values for Power Level 5 (32.5 dBm), 15 (13 dBm) and 19 (5 dBm) according to Target values. The Power levels may differ from Phoenix mentioned target power levels.

Press "Save and Continue" and the tuning continues with DCS1800 power level tuning.

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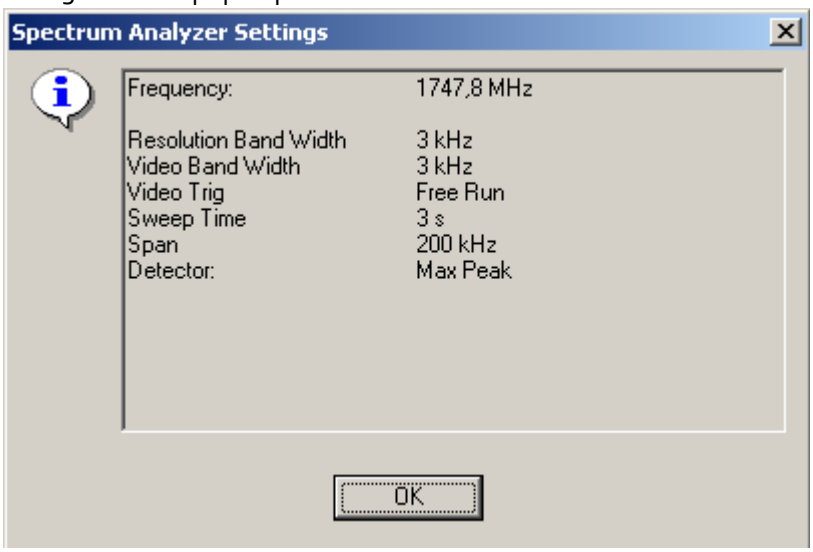
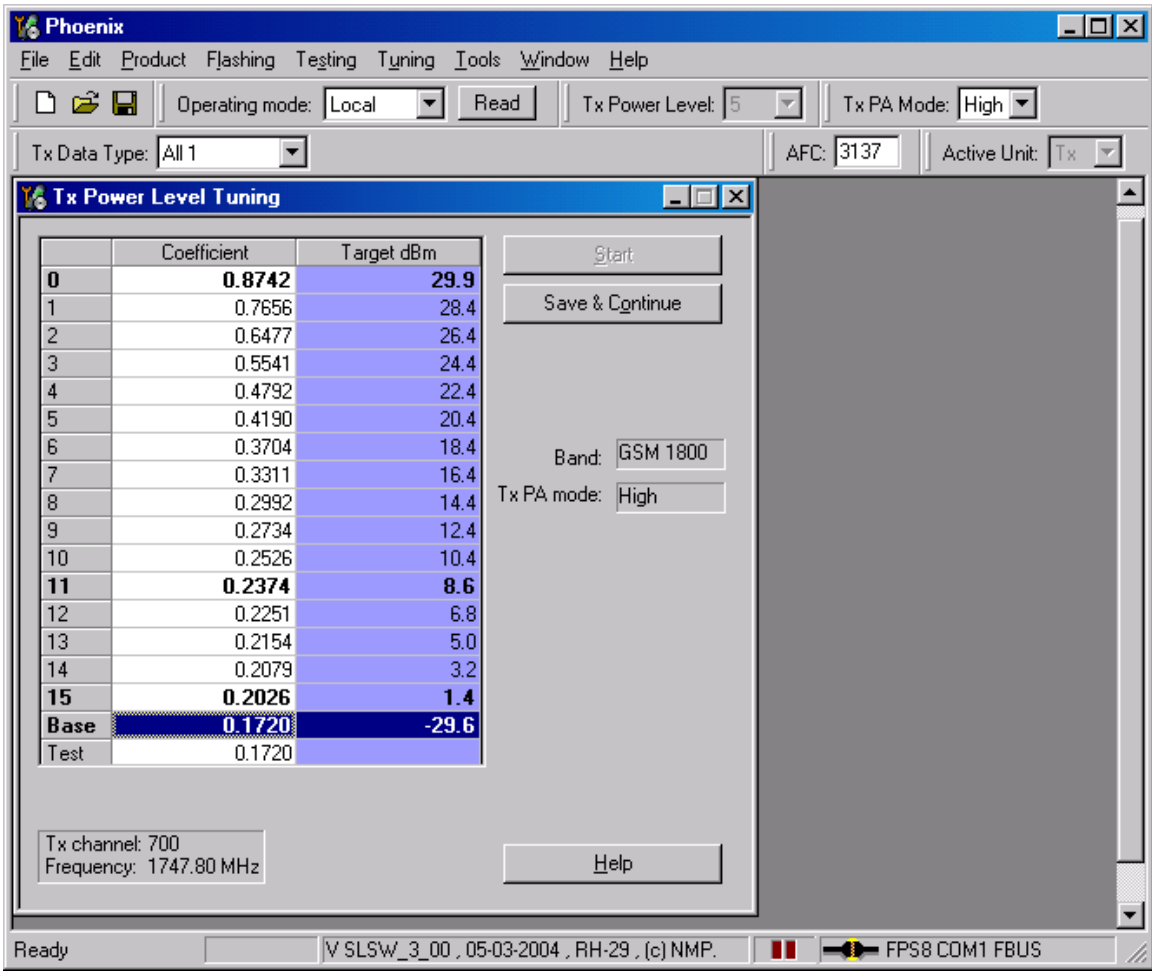
The following window pops up:



If you are using a spectrum analyzer, make the necessary settings. Press OK to continue. The setup should now look like this:



Tune Base level to -28dBm.

Adjust DAC Values for Power Level 0 (29.9dBm), 11 (8.6dBm) and 15 (1.5dBm). The Power

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levels may differ from target power levels mentioned in Phoenix.

Press "Save and Continue" and TX Power Level Tuning is finished.

Auto-Tune with Phoenix

Automatic tuning for RH-29 RF parameters is possible. Auto-Tune tunes all RF parameters for both of the bands.

Needed equipment

- PC running Nokia Phoenix SW
- Test jig MJ-21
- Power source
- Cables: RF-cables for measurements and GPIB-cable(s) to control test equipment
- R&S CMU200

OR one TX- and one RX-equipment and RF-splitter:

TX:

- Agilent E4406 (VSA series transmitter tester)
- Agilent E4445 (PSA series transmitter tester)
- Rohde&Schwarz, FSE-family of Signal Analyzers
- Rohde&Schwarz, FSIQ-family of Signal Analyzers

RX:

- Agilent ESG family of RF Signal Generators
- Rohde&Schwarz, SME-family of Signal Generators

Set Loss

Path losses caused by test jig MJ-21 and RF-cables must be set correctly before tuning. To be able to change these values, there have to be some phone connected to Phoenix. Select right connection type from Phoenix and set operating mode to local mode.

Select File Alt-F

Scan Product P

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Wait until phone information is shown in the lower right corner of the screen.

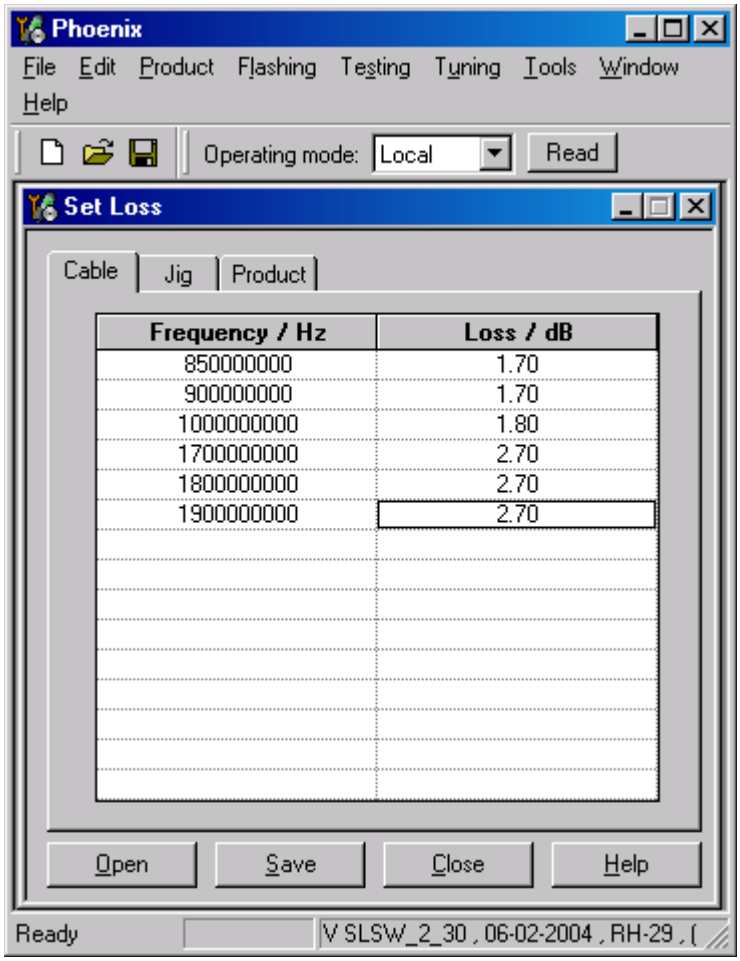
Now you can change values for path losses and select right jig for the prouct.

Select Tuning Alt-u

Set Loss o

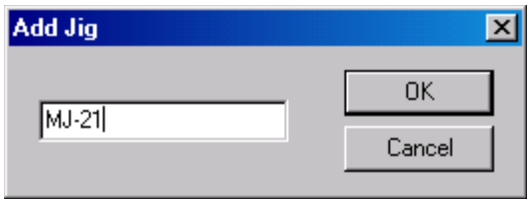
Set losses for RF-cables as shown in figure below:

Figure 16: Set loss for RF-cable(s)



Select used test jig (MJ-21) for the product, from the "Product" menu. If MJ-21 is not there, you have to add it. See figure below:

Figure 17: Add jig for the product



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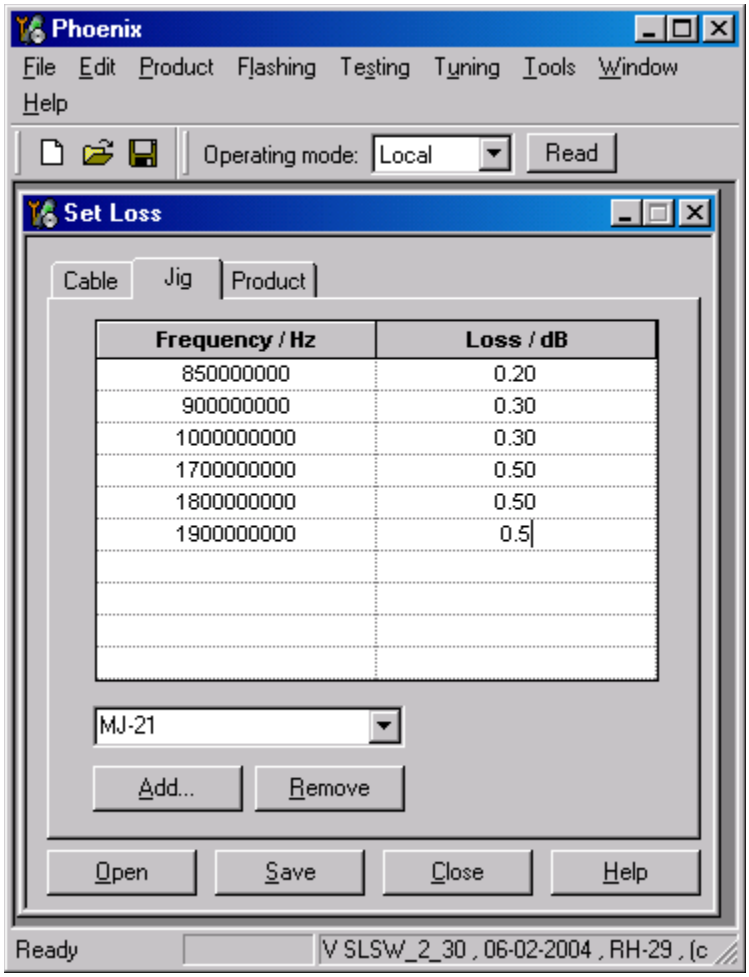
Set losses for the jig as shown in figure below:

Figure 18: Set loss for test jig



Tuning

Connect the test jig MJ-21 to PC and to measurement equipment (if you are using R&S CMU200, use RF2-port). Connect the engine board to jig, turn power on. Run Phoenix. Select right connection type from Phoenix and set operating mode to local mode.

Select File Alt-F

Scan Product P

Wait until phone information is shown in the lower right corner of the screen.

Check that there is right jig selected and losses set correctly, as described previously.

Start auto-tune

Select Tuning Alt-u

Auto-Tune A

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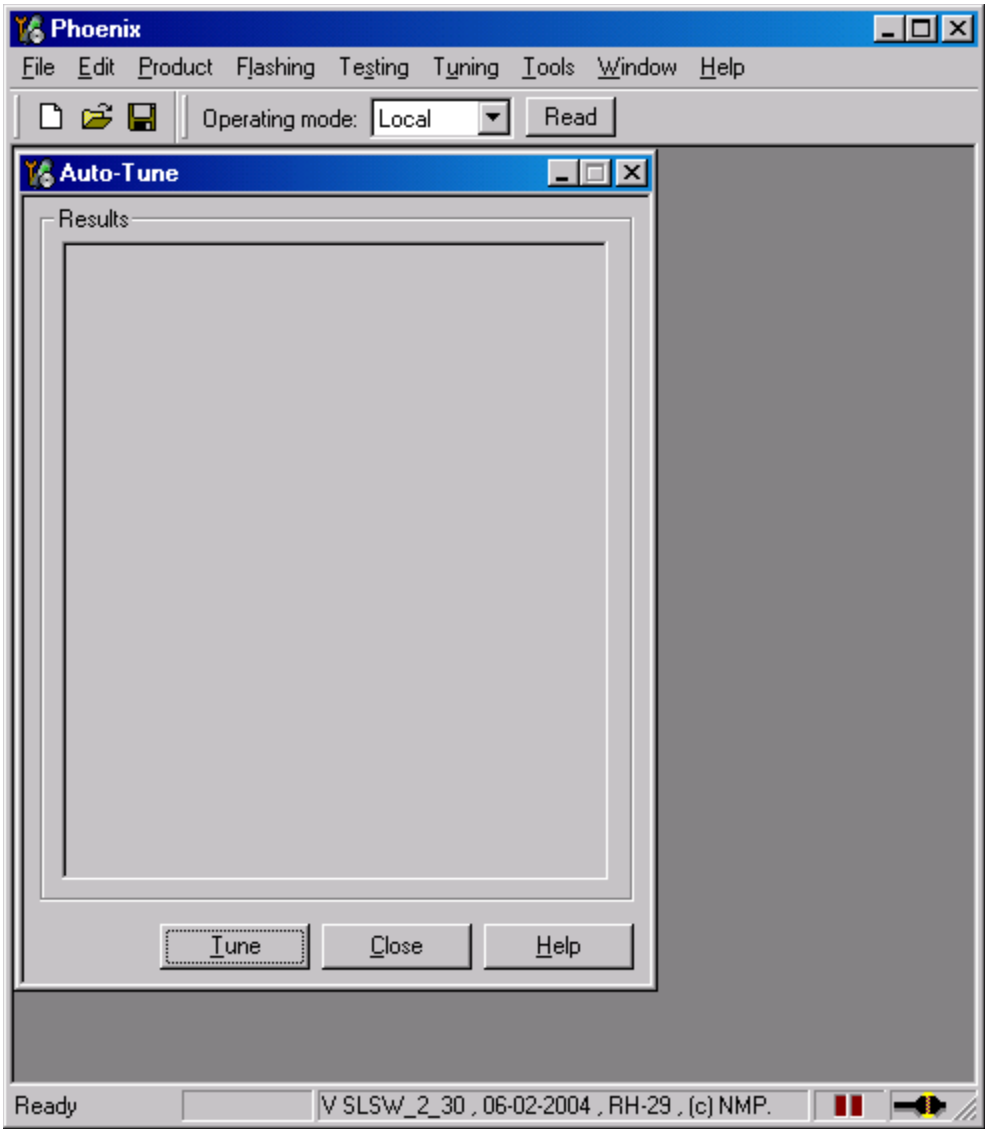
See figure below:

Figure 19: Auto-Tune



Wait until Auto-Tune starts properly, that is "Tune"-button becomes active.

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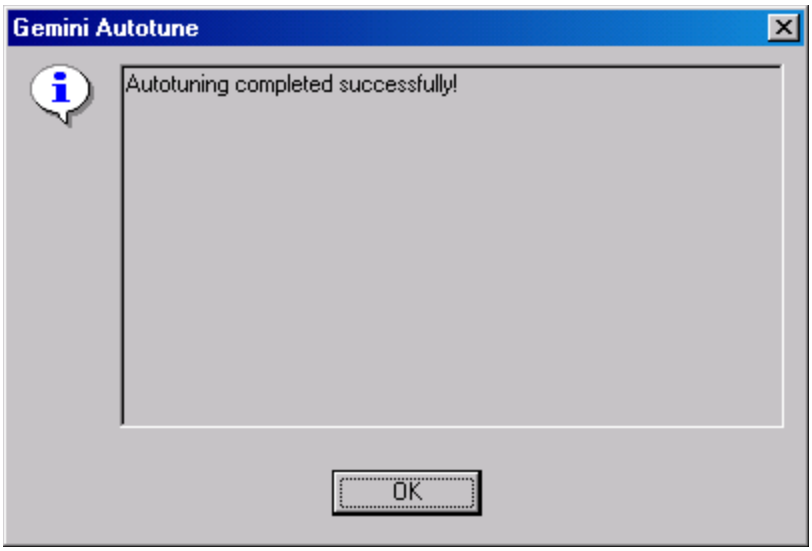
Press "Tune", and Phoenix will do all the tunings, both TX and RX. That will take about a couple of minutes. If autotuning can be made successfully, you will see following message:

Figure 20: Autotuning done



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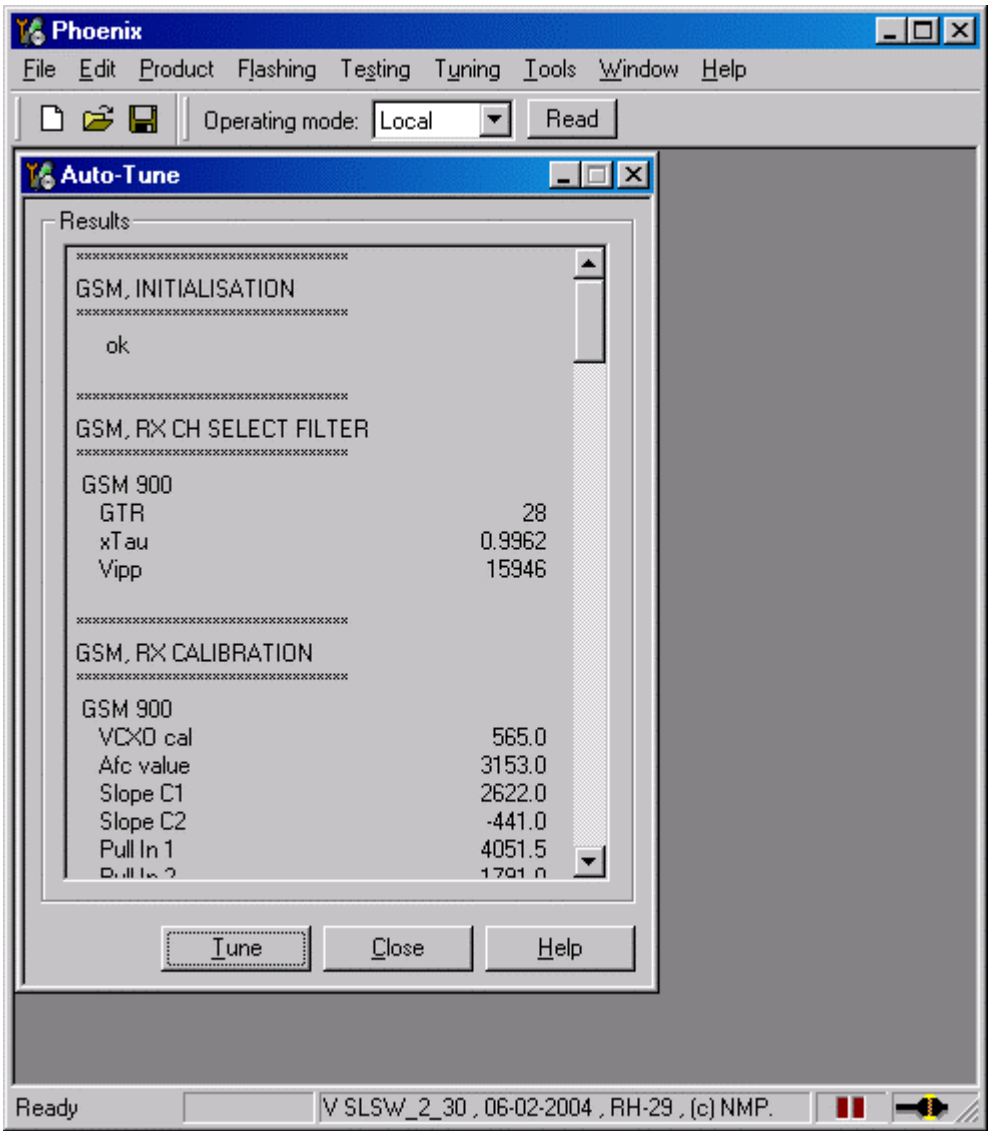
Press "OK", and you'll see the tuning results, as in figure below:

Figure 21: Results of Auto-Tune



Tunings are now done.

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